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PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.
1911.

PART III.

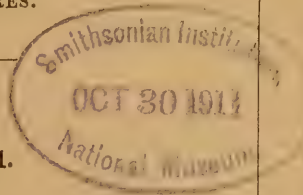
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PROCEEDINGS
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GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.

EXHIBITIONS AND NOTICES.

March 21, 1911.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

THE SECRETARY read the following report on the additions made to the Society's Menagerie during the month of February, 1911 :—

The number of registered additions to the Society's Menagerie during the month of February last was 123. Of these 38 were acquired by presentation, 47 by purchase, 8 were received on deposit, 24 in exchange, and 6 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 138.

Amongst the additions special attention may be directed to :—

2 Northern Lynxes (*Felis lynx isabellinus*), from Tibet, presented by Capt. D. G. Oliver, on Feb. 17th.

1 Dwarf Mongoose (*Helogale varia*), new to the Collection, from Lamu, presented by the Rev. W. D. Braginton, on Feb. 27th.

1 Black-footed Polecat (*Putorius nigripes*), new to the Collection, from N. America, received in exchange on Feb. 16th.

2 Cat-Bears or Pandas (*Ailurus fulgens*), from Nepal, purchased on Feb. 20th.

1 European Bison (*Bison bonasus*), from Lithuania, presented

by H.G. The Duke of Bedford, K.G., President of the Society, on Feb. 23rd.

2 Dybowski's Deer (*Cervus hortulorum*), from Manchuria, new to the Collection, presented by Sir Edmund Loder, Bart., F.Z.S., on Feb. 23rd.

1 Aldunati's Finch (*Phrygilus aldunatii*), from Chili, new to the Collection, presented by Miss Phillis True, on Feb. 13th.

1 King Penguin (*Aptenodytes pennanti*), from the Antarctic Seas, presented by Señor Clemente Onelli, on Feb. 11th.

Mr. D. SETH-SMITH, F.Z.S., the Society's Curator of Birds, exhibited a living Hybrid Duck, which was believed to be a cross between the White-eyed Pochard (*Aythya nyroca*) and the Marbled Duck (*Marmaronetta angustirostris*). It was hatched at Scampston Hall, Yorkshire, from a clutch of eggs laid by a Marbled Duck at Lilford Hall, Northamptonshire. The bird displayed the characteristic markings of *Marmaronetta*, but the general colour was dark reddish brown. It had been presented to the Society by Mr. W. H. St. Quintin, F.Z.S.

Mr. R. I. POCCOCK, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens, exhibited:—

(1) A pair of Otter cubs about seven weeks old, which were found under a landing-stage at Tewkesbury, and were presented to the Society by Mr. W. Baring Bingham, F.Z.S.

(2) The skin of an adult female Chacma Baboon (*Papio porcarius*) representing an apparently undescribed local race of that species, which he proposed to name and diagnose as follows:—

PAPIO PORCARIUS, subsp. *GRISEIPES* *.

Abstract P. Z. S. 1911, p. 17 (March 28th).

Of the size, general appearance, and coloration of the typical form from Cape Colony, but distinguished by the absence of black hairs from the upper sides of the hands and feet, the extremities of the limbs and tail being clothed with grizzled or annulated hairs.

Loc. of type: Potchefstroom in the Transvaal.

This animal was presented to the Society in 1904 by Mr. James Adams, whose son had brought it from the above-mentioned locality. She was adult at the time and died in 1910. On arrival she was seen to differ in the characters enumerated from the ordinary South African Chacmas, commonly received by the Society, many of which are shipped from Algoa Bay and all of which are believed to come from some part of Cape Colony. This belief is borne out by Mr. W. L. Selater's † description of

* The complete account of this new subspecies appears here, but the name and a preliminary diagnosis were published in the 'Abstract,' No. 93, 1911.—EDITOR.

† 'The Fauna of South Africa: Mammals,' i. p. 14, 1900.

P. porcarius, in which it is stated that "the lower part of the arms and legs [are] darker than the rest of the body, almost black, the upper part of the hands and feet quite black." Since Mr. Sclater further adds that "there are in the South African Museum skins and skulls from the Stellenbosch, Tulbagh, Worcester, Beaufort West, and Albany divisions of the Colony," it may be inferred that his description of the typical form of the species was taken from the material in question.

During its lifetime in the Gardens, the baboon did not show any change in colour, so that there are no grounds for believing that the differences above pointed out are due in any way to age. The Society also possessed at one time a second specimen, an adult male, deposited by the Hon. Walter Rothschild, which exactly resembled the type; but for this, unfortunately, no precise locality was known. The exact northern range in S. Africa of the typical or black-handed Chacma appears to be unknown; but on the evidence supplied by the type specimen of *P. porcarius griseipes*, it may be supposed that the latter supplants the former at least in the Southern Transvaal. Chacmas have been recorded by Mr. Vaughan Kirby from the country between Beira and the Zambesi; and according to Mr. Sclater the species is abundant in Natal and the Transvaal; but it does not appear that any specimens from the latter country have been described or critically examined hitherto.

Text-fig. 145.



Black-footed Polecat (*Putorius nigripes*).

(3) A specimen of the North American Black-footed Polecat (*Putorius nigripes*) (text-fig. 145), recently received in exchange from the Zoological Society of Washington.

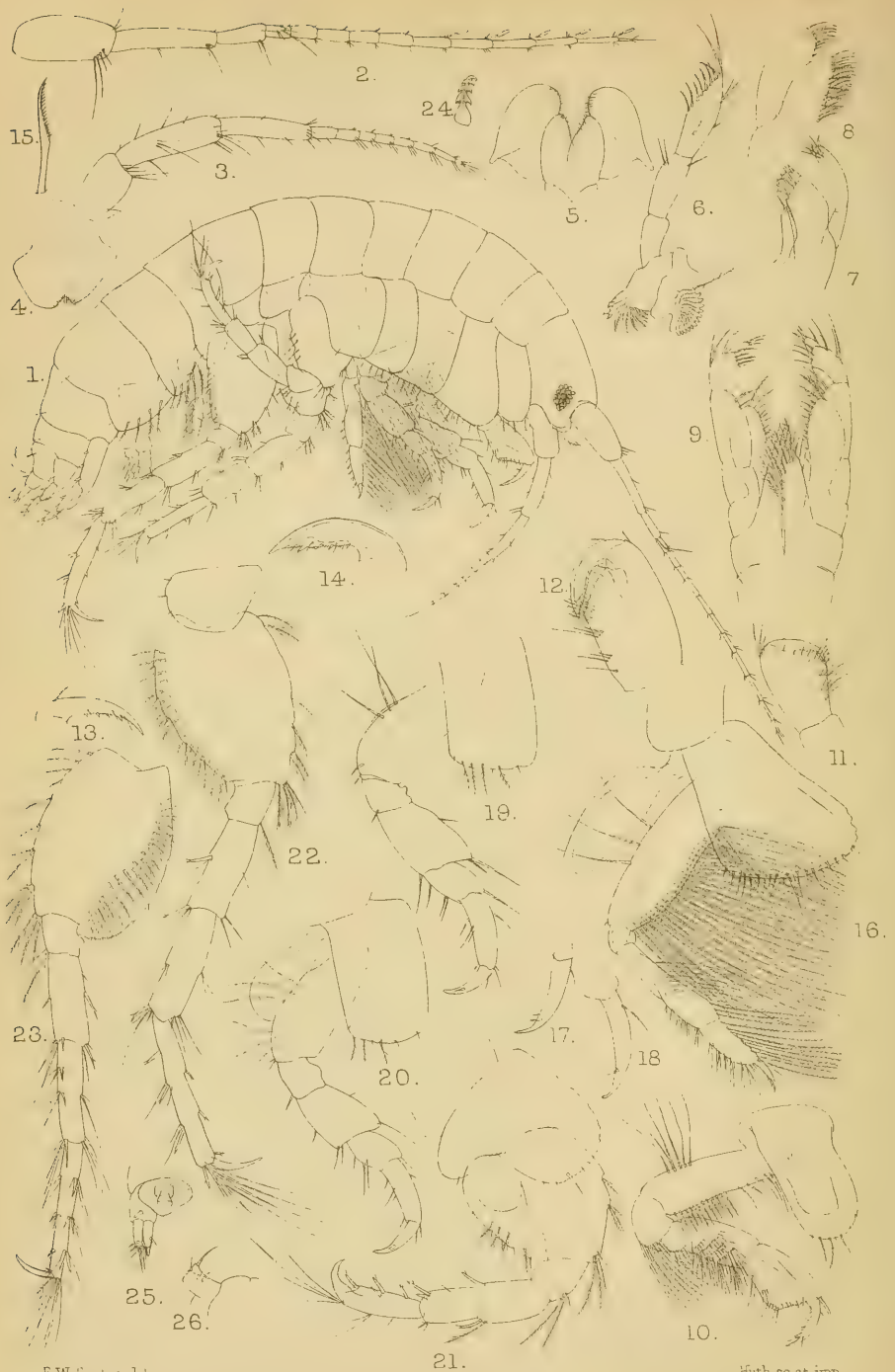
The peculiar coloration of this animal, taken in conjunction

with its behaviour in captivity, suggests that it belongs to one of the warningly coloured species of Mustelidæ. Although the upper surface of the head, neck, and body is tinted with buff, owing to the terminal portion of the long hairs being that colour, the whiteness of the underfur, and of the basal portion of the long hairs of these areas, together with that of the sides and under surface of the body and of the greater part of the tail and face, gives the impression of a whitish animal which must be conspicuous against any dark background. Sharply contrasted with the creamy tint of the body is the jet-blackness of the legs and of the tip of the tail; while the whiteness of the face is emphasised by a broad black band stretching across the lower part of the forehead and the base of the nose and involving the bright bead-like eye on each side.

Apart from its coloration, this Polecat exhibits in unmistakable manner that fearlessness which is so marked a feature of protected animals. It never makes any attempt to keep in the background or lie hid, like a savage cat, when disturbed, but comes boldly to the bars of the cage with threatening aspect, as if eager to attack the intruder, uttering every now and again a shrill chattering scream. Its obstinate pertinacity, indeed, in keeping to the front when any human being is in sight makes the opening and shutting of the door of the cage for cleaning and feeding purposes a matter of serious difficulty. Nothing but a bass-broom, which few small mammals will face, has any effect in making it beat a retreat. Finally, when actively interfered with by being netted, it emits the foetid odour so characteristic of species of the genus *Putorius*. The combination of characters here mentioned—namely, the repulsive smell, the courage and fearlessness of exposure, the conspicuous coloration—are all found in the Skunks, the stock examples amongst the Mammalia of protected self-advertisers. Added to these attention-arresting characters is the penetrating scream comparable as a warning signal to the rattling of a Porcupine's tail. These facts justify the placing of the Black-footed Polecat in the category of aposematic Mustelines, an account of which has already been published by the Society*.

(4) The antlers of an old male of the Manchurian Wapiti (*Cervus xanthopygus*), that recently died in the Gardens, to show the natural variation in the position and growth of the second or "bez" tine. In one antler this tine was much smaller than the first or "brow" tine, and was situated nearly midway between it and the third or "trez" tine, apparently as in the specimen of this Deer described by Mr. Lydekker as *C. bedfordi*; but in the other antler the bez-tine was as long as the brow-tine and placed close above it as in normal antlers of the stags of this group.

* R. I. Pocock, P. Z. S. 1909, pp. 944-959.



E.W. Sexton del.

Huth, sc. et imp.

LEPTOCHEIRUS PILOSUS (Schubach).



E.W. Sexton, del.

Hath. sc. et imp.

1-9. *LEPTOCHEIRUS BUTTATUS* Grube. 10-12 *L. PINGUIS* Stimpson
 13-16. *L. HIRSUTIMANUS* Bate. 17-20. *L. BISPINOSUS* Norman.



E.W. Sexton, del.

Holase et al.

LEPTOCHEIRUS PECTINATUS Norman.

PAPERS.

26. On the Amphipod Genus *Leptocheirus*.

By E. W. SEXTON, Marine Biological Laboratory, Plymouth*.

[Received December 22, 1910 : Read March 21, 1911.]

(Plates XVII.-XIX.†, and Text-figure 146.)

The genus *Leptocheirus* was instituted by Zaddach in 1844, with the type species *L. pilosus*. So much discussion has arisen over this species that it seemed desirable to settle the matter by reference to the actual specimens, should it prove possible to trace them. Dr. Braun, in whose keeping at the Königsberg Museum they were discovered, most kindly sent them to me for examination and also granted permission to dissect and figure one of the specimens, so that the vexed question might be finally set at rest. I am deeply indebted to him, and to all those also who have so generously assisted me in this investigation : to Canon Norman, for the loan of specimens of *L. subsalsus*, *pinguis*, *hirsutimanus*, *guttatus*, and *pectinatus*; to Monsieur Chevreux for specimens of *L. cornuaurei*, *tricristatus*, and *dellavallei*; to Dr. Kükenthal and Dr. Zimmer for permission to examine Grube's specimens of *Protomedeia hirsutimana*? and *P. guttata*; to Dr. Hjalmar Théel and Dr. Holmquist for the trouble they have taken in searching for Ohlin's specimen of *L. aberrans*; to Professor Steuer for his assistance in tracing Heller's specimen of *P. hirsutimana*; to Dr. Otto Pesta for the description and figures of this same specimen, by which its identification became possible; and to Professor Vayssière and Monsieur Collin, of Cette, for the help given in searching for Catta's specimen of *massiliensis*.

It will be noted that the number of species has been reduced.

L. cornuaurei Sowinski and *subsalsus* Norman become synonyms of the type species, the one being the full-grown male, and the other the full-grown female. Norman's record is very interesting with regard to the distribution, confirming Zaddach's account, both being for fresh or almost fresh water. All the other species of the genus, so far as yet known, are marine.

I have also shown, I hope conclusively, the identity of *L. pectinatus* Norman with *L. dellavallei* Stebbing, which indeed Mr. Walker has always maintained. *L. pectinatus* is, in my opinion, the young form sexually mature but not full-grown, while *L. dellavallei* is the fully developed animal. Figures are given of the characters on which Chevreux (16) p. 91, and Norman (36) pp. 87, 88, separated them, to prove that the differences are merely those due to sex and development. The question of distribution is also discussed by these authors in separating the species, *pectinatus* having always been found near the shore, and *dellavallei* at greater depths, but our present

* Communicated by Dr. W. T. CALMAN, F.Z.S.

† For explanation of the Plates see p. 593.

knowledge of the bathymetrical limits of any species is far too inadequate to base any conclusions upon. Grube's *hirsutimana* from the Adriatic is the same species.

L. tricristatus Chevreux becomes a synonym of *guttatus* Grube. An interesting point in this species is the varying development of different characters, notably the antennæ, the last peræopod, and the last uropods.

L. bispinosus Norman I consider identical with the species described and figured by Della Valle as *L. guttatus*. Heller's *P. hirsutimana* is to be referred to this species (see p. 585).

I have been unable to trace the type specimens of two species, *L. aberrans* Ohlin, and *Protomedeia hirsutimana* var. *massiliensis* Catta. The only specimen of *aberrans*, dissected by Dr. Ohlin for the purpose of description, appears unfortunately to have been lost.

There is nothing to add to Mr. Stebbing's definition of the genus, 'Das Tierreich,' p. 625, except that the outer ramus of uropod 3 in all the species is 2-jointed, the terminal joint rudimentary.

The development of the secondary sexual characters in the male can only be definitely stated in two species, *L. pilosus* and *pinguis*; a great deal more material must be examined before it can be decided whether the rule which applies to these species holds good for the whole genus or not. In *pilosus* and *pinguis* the first gnathopod in the male is longer than the second, the hand is greatly developed, the palmar margin concave; while in the female, on the contrary, the first gnathopod is shorter than the second, and the palmar margin is convex. The full-grown female, in all the other species, agrees with this description. I find another distinction between the sexes in the type species (*L. pilosus*), in the shape of the basal joint of the 5th peræopod (see Pl. XVII. figs. 22 & 23); but as this is the only species in which I have had the 5th peræopods of both sexes, I cannot say if this distinction is generic or only specific.

The species now included in the genus are as follows, arranged in chronological order, with their principal distinguishing characters:—

1. *L. pilosus* Zaddach 1844, = *L. cornuauzei* Sowinski, 1898, the ♂, and *L. subsalsus* Norman, 1908, the ♀. Pleon-segments not dentate: accessory flagellum 1-jointed: gnathopod 1 greatly developed in ♂, longer than gnath. 2; shorter than gnath. 2 in ♀; 5th joint in ♂ powerful and curved, 6th bent inwards at right angles to the 5th, palmar margin concave; palmar margin convex in ♀: finger of gnath. 2 almost straight, apex acute.
2. *L. pinguis* Stimpson 1853. Pleon-segments 4, 5, & 6 each with 2 dorso-lateral angles: accessory flagellum long, 6-8-jointed: hind margins of sideplates 1-4 serrate, spiniferous: hand of gnathopod 1 greatly developed in ♂, and much longer than gnath. 2; much shorter than gnath. 2 in ♀; palmar margin concave in ♂, convex in ♀: finger of gnath. 2 as in *pilosus*.

3. *L. hirsutimanus* Bate 1862 = *Boeckia typica* Malm 1871. Pleon-segments not dentate, the 4th with a dorsal depression : accessory flagellum 6-jointed : sideplate 1 small, hidden by the large sideplate 2 : finger of gnath. 2 as in *pilosus* : fingers of pereopods 3-5 bifid : uropod 2 unusually massive.
4. *L. guttatus* Grube 1864 = *Ptilocheirus tricristatus* Chevreux 1886. Pleon-segment 4 with 3 medio-dorsal angles or teeth : superior antennæ not much longer than inferior ; accessory flagellum 2-3-jointed ; palmar margin convex in ♀ : finger of gnath. 2 unguiform, acute : falciform processes of uropods 1 and 2 of great length : inner ramus of uropod 3 tipped with 1 spine.
5. *L. pectinatus* Norman 1869 = *Protomedeia fasciata* Costa 1864 and *L. dellavallei* Stebbing 1899 : pleon-segments 4 and 5 each with 2 dorso-lateral angles : sideplate 1 small, hidden by the large sideplate 2 : accessory flagellum 2-3-jointed : palmar margin, gnath. 1, concave in ♂, convex in ♀ ; finger of gnath. 1 exceeding the palm in length : finger of gnath. 2 straight, laminar, tipped with setæ.
6. *L. aberrans* Ohlin 1895.
7. *L. bispinosus* Norman 1908 = *Protomedeia hirsutimana* Heller 1866 and *L. guttatus* Della Valle 1893 : resembles *guttatus*. Pleon-segments 4 and 5 each with 2 dorso-lateral angles : accessory flagellum 5-jointed : palmar margin, gnath. 1, convex in ♀ : 2nd joint in gnath. 2 unusually long ; finger as in *guttatus* : falciform processes of uropods 1 and 2 of great length : uropod 2 with two clusters of feathered setæ on the lower margin of the inner ramus.

Fam. PHOTIDÆ.

(For synonymy see Stebbing, Das Tierr. Lief. 21, p. 603.)

Gen. LEPTOCHEIRUS Zaddach.

(Stebbing, p. 625.)

LEPTOCHEIRUS PILOSUS Zaddach. (Plate XVII.)

1844. *Leptocheirus pilosus* Zaddach (53) pp. 8 & 9.
 1848. " " Müller (32) p. 62.
 1862. *Protomedeia pilosa* Spence Bate (1) p. 168.
 1873. *Leptochirus pilosus* Möbius (30) p. 117.
 1878. *Protomedeia pilosa* Zaddach (54) pp. 18 & 19.
 1888. *Leptocheirus pilosus* Stebbing (42) see p. 1707 for references.
 1898. " *cornuaurei* Sowinski (41) p. 470, pl. ix. figs. 9-22.
 1906. " *pilosus* Stebbing (44) p. 630.
 1908. " *subsalsus* Norman (38) p. 307, pl. xii. figs. 1-6.
 1910. " *cornuaurei* = *subsalsus* Chevreux (18) p. 2.

This species was fully described by Zaddach in 1844, and the accuracy of his description will be seen on comparing his account with the figures here given. In his later work, 'Die Meeres-

Fauna an der preussischen Küste,' is an interesting note on the distribution of the species. It was found, so Zaddach states, both in fresh and in salt water; by Rathke in 1843 in a large fresh-water lake, the Geserich See, and by Zaddach himself, about the same time, in the sea at Dantzig. It is not known under what circumstances Rathke obtained his specimens, whether he collected them himself near the banks, or whether they were given to him by the fishermen. Zaddach, 34 years later, dredged the southern part of the lake in search of the species, but his efforts proved fruitless.

The type* specimens are preserved in the Königsberg Museum, and are labelled "Protomedeia pilosa Zadd. Rauschen, Ostsee IX. 1866."

The next record, also from the Baltic, is that of Müller, who noted the species as not rare in Greifswalder Bodden. He pointed out the presence of a minute 1-jointed accessory flagellum on the superior antenna, which had been overlooked by Zaddach.

The next authentic record of the species is in 1898, when Sowinski described and figured the adult male as *L. cornuaurei*.

In 1908 Canon Norman described and figured the female under the name of *L. subsalsus* from specimens found by Mr. Gurney in Norfolk, in fresh or almost fresh water.

In a note published in July, 1910, Monsieur Chevreux points out that *cornuaurei* Sow. is the male of *subsalsus* Norman.

The examination of the type species which I have been enabled to make and the comparison of it with specimens of both *cornuaurei* and *subsalsus*, prove beyond question the identity of all three forms, *pilosus* being the young female, not sexually mature, *cornuaurei* the full-grown male, and *subsalsus* the full-grown female.

The specimens examined were:—

Zaddach's two types from the Baltic, measuring 4 mm. *around the curve*; young females, not sexually mature.

4, ♂ and ♀, from muddy piles, R. Bure, Norfolk, Canon Norman's collection, measuring 5 mm. in a straight line.

4, ♂ and ♀, from the coast of Algeria, sent by Monsieur Chevreux, measuring 4-4.5 mm. in a straight line.

Description.

Body (Pl. XVII. fig. 1) smooth, moderately compressed; pleon without teeth, but last four segments with a seta inset on either side of the median line.

Head about as long as the first two peræon-segments; lateral corners rounded, not prominent.

Eyes oval in the small specimens, almost round in the large ones. The ommatidia, which are large and few in number, are

* Prof. Braun informs me that these specimens were collected by Zaddach himself in the Baltic at Rauschen, about 35 km. northwest of Königsberg, in September 1866, and are to be regarded as the types of the species. As the original description was published in 1844, they are not, strictly speaking, types, but rather, perhaps, *meta-types*.

darkly pigmented in the centre of the eye; the outer ring in the young animal is quite colourless, though this, of course, may only be due to the fading of the pigment, little of which is left in Zaddach's specimens, while in Chevreux's it is still fresh and black.

Sideplate 1 free of sideplate 2, but not as deep and not quite half its width; obtusely rounded. Sideplate 2 the deepest of all; expanded inferiorly; in Zaddach's specimens and Norman's small one it is deeper than broad, but in the large specimens it is more expanded in proportion to the other sideplates, in the largest of all, a female, it is almost twice the width of sideplate 3; hind margin straight, front angle produced and rounded. Sideplates 3 and 4 subequal, deeper than broad, of equal width throughout; front and hind margins straight; the 5th has the anterior lobe as wide and as deep as sideplate 4, posterior lobe small; 6th and 7th small; 1-5 with a few plumose hairs and setules on the inferior margin.

Pleon.—Segment 3 the largest; the 3rd-6th each with 2 setæ, one on either side of the median line, those of the 4th and 5th segments the longest. These setæ are inset submarginally on the posterior margin in the same position as the angles or teeth of the other species. Hind margin of the 2nd segment straight; that of the 3rd rounded; inferior margins of 1-3 with plumose sensory hairs, those of the 2nd longer and more numerous; hind margins 1-3 crenulate, 2-3 crenulations each with a setule inset.

ANTENNÆ (figs. 2 & 3).—*Superior Antenna* (fig. 2) much longer than the inferior, about half the length of the body: 1st joint of the *peduncle* stout; 2nd much more slender and longer than the 1st in the large animal, in Zaddach's smaller specimen it was subequal to the 1st in length; 3rd not quite half the length of the 2nd. *Primary flagellum*: Zaddach gives the number of joints as 12, Norman as 13; one of Zaddach's specimens, the smaller of the two, had 11 joints, the other 12; Norman's largest specimen had 14; Chevreux's 14, one specimen with 14 in one antenna and 15 in the other; the difference in number is evidently due to development. The proximal joints are short, the distal ones increasing in length, each, from the 5th or 6th to the second last joint, being furnished with a stalked sensory filament in addition to the small setæ. *Accessory flagellum* not as long as the 1st joint of the primary. It consists of 1 small joint, which is so constricted near the apex as to give the appearance of a minute second joint; furnished with 3 apical setæ, one of great length, and 2 long setæ above the constriction. Zaddach completely overlooked this small appendage, which Müller was the first to note, and indeed it might, as Müller says, easily escape attention, were it not for the long outstanding apical bristles.

Inferior Antenna (fig. 3).—The proportions of the last three joints of the *peduncle* are as given by Zaddach; 3rd short, nearly twice as broad as the succeeding joints; 4th the longest; 5th a

little shorter than the 4th. The *flagellum* is about half as long again as the 5th joint; it is composed of 8 joints in Zaddach's specimens, of 10 in the larger ones, the terminal joint in all microscopic.

ORAL PARTS.—*Upper Lip* (fig. 4): apex asymmetrically bilobed.

Lower Lip (fig. 5) large; outer lobes rounded, inner lobes appear to be coalesced at the base.

Mandibles (fig. 6).—Both *cutting-plates* and *accessory-plates* divided into 4-5 strong rounded teeth, the lowest being the largest; 7 dentate spines in the *spine-row* in Zaddach's specimen, 9-10 in the large animals, the first two or three laminar. The *molar* is large and cylindrical, crown ridged with rows of teeth, and edged with flat spines, furnished with a long feathered seta above; in the figure the molar is not well represented, being bent back to show the other portion of the mandible more clearly. The *palp* is very large; 3rd joint the longest, tipped with 4 strong curved bristles, the distal inner margin furnished with a double row of finely serrate bristles.

Maxilla 1 (fig. 7) as described by Zaddach: *inner plate* large, with 1 long plumose seta; *outer plate* with 11 strong spines on its apex, 3 dentate ones at the upper angle, and the others arranged in pairs, 1 bifurcate and 1 dentate together; in the figure only one of the rows can be shown. The 2nd joint of the *palp* widens towards the truncate apex, which is furnished with 4 strong short spines inset apically, and a diagonal submarginal row of 4 setæ.

Maxilla 2 (fig. 8) as large as maxilla 1; *inner plate* the smaller; the apices of both plates carry long curved stiff bristles; the inner margin of the inner plate has 2 rows of plumose setæ, setting out at different angles, one row containing 3 times as many setæ as the other.

Maxillipeds (fig. 9).—*Inner* and *outer plates* well developed; *inner plates* narrowed distally, the truncate apices inset with 3 flat spines, outer margins with 3 setiform spines distally; a row of 7 long jointed plumose setæ crosses each of the plates diagonally from the outer angle of the apex to the inner margin, extending more than halfway down the latter. The *outer plates* are widened distally; in Zaddach's specimen the plate on the right side is furnished with 1 long plumose seta apically and 8 graduated strong spines along the inner distal margin; the plate on the left has 2 of the plumose setæ apically, and 7 of the graduated spines; the outer surface carries numerous stiff curved bristles along the inner margin. *Palp*, 2nd joint much the largest; 3rd much produced on the inner surface over the insertion of the finger; finger small, obtuse, tipped with strong serrate setiform spines. The 2 basal joints and the 1st-3rd joints of the palp are provided on the outer surface with numerous long delicate plumose setæ.

The *First Gnathopod* (figs. 10-15) is longer than the second in the male, shorter than the second in the female. It is characterised by the remarkable development of the 5th-7th joints

in the male. In the female (fig. 11) the hand is shorter than the preceding joint and lies in the same plane with it, but in the male it is a quarter as long again as the 5th joint, and is carried bent at right angles to it (fig. 12). The finger differs also: in the male it is much stouter, more curved, and with a depression in the inner margin proximally. The long 2nd joint is furnished with a cluster of long delicate setæ on the posterior margin, and a row of short plumose setæ on the anterior margin, with another row of longer similar ones on the inner surface. 3rd joint bulging behind; 3rd and 4th fringed posteriorly with long plumose setæ; 5th joint with transverse rows of plumose setæ, and 4 fan-like clusters of rigid serrate bristles on the posterior margin. These bristles (fig. 15) are found on the 5th joint of the first gnathopod in all the species of the genus. The 6th joint or hand is subequal to the 5th in length in the immature specimen (fig. 10); distally widened; palm slightly oblique; palmar margin microscopically pectinate, palmar angle with a row of spines on the outer side, and 1 large spine on the under side, with the tip of the finger fitting between them. The outer row consists of 6 graduated slender spines, the first much the longest, the shafts of which are produced apically into two unequal processes, with a flat, delicate, feathered end-piece between the processes. In one specimen there were 6 on one gnathopod and 7 on the other. On the inner side of the palmar angle a very large stout sensory spine is inset, accompanied by 4 short stumpy bristles similar in construction to those of the outer row. A row of these stumpy bristles is found submarginally on the under surface of the palm, and 3 or 4 rather larger ones on the outer side. The finger in the young (fig. 10) is stout and curved, as long as the palm, also microscopically pectinate, with a short decurrent tooth near the apex, 2 setæ inset in the notch, 1 smaller tooth behind, and 1 setule proximally. The full development of the finger of the female is shown in fig. 13 and of the male in fig. 14.

Second Gnathopod (figs. 16-18).—2nd joint very long, laminar, with two rows of exceedingly long plumose setæ anteriorly, one marginal, and the other submarginal on the under surface; posterior margin with only 3 or 4 long simple setæ. A chitinous ridge extends diagonally across the distal half of this joint, and terminates at the posterior angle of the 3rd; this appears to be the "crista" referred to by Zaddach ("in superficie externa crista quadam a basi secundi articuli ascendente"). The 4th, 5th, and 6th joints are practically subequal to each other in length; distal margin of the 4th joint with very long plumose setæ on the under side; posterior margins of the 5th and 6th with fan-like clusters of short, stiff, finely serrated setæ, anterior margins with long plumose setæ, the number of which increases a little with growth, the smallest specimen having 9 on the 6th joint and the largest 11, 3 on the 5th joint in all specimens. The 6th joint is slightly narrowed distally. The finger is almost

straight, the tip curved and 2 setules inset subapically. I have given figures (see figs. 17 & 18) from both Zaddach's and Norman's specimens drawn to the same magnification.

Pereopods 1 and 2 (figs 19 & 20) glandular; 4th joint very much expanded, as noted by both Zaddach and Norman; 6th joint as long as the 4th, but much narrower; 5th only half the length; finger strong, two-thirds the length of the preceding joint, with the gland-aperture at the tip.

Hinder Pereopods (figs. 21-23) rapidly increase in length; the 6th joint in all is much narrower and longer than the preceding. In pereopod 3 the joints are stout and short, furnished with a few strong sensory spines; 2nd joint obliquely oval, about as wide as long, the anterior margin inset with 3 clusters of jointed sensory ciliated hairs, posterior margin slightly crenulate, with a setule in each crenulation, and with 4 plumose hairs submarginally; finger about half the length of the 6th joint, falciform. In pereopod 4 the 2nd joint is oval, longer than wide, anterior margin with clusters of the sensory plumose hairs, posterior margin crenulate, with a submarginal row of close-set long ciliated hairs. In pereopod 5 there is a remarkable difference in the shape of the basal joint in the male and female. In the female the joint is oval, the posterior expansion narrowing distally, while in the male it widens distally and is produced downwards in a rounded lobe, but the curious part is that the ciliated sensory hairs, instead of being inset close to the margin as in the female, are at some distance from the margin on the under surface, but yet give the same outline as in the female (*cf.* figs. 22 & 23).

Pleopods (fig. 24).—Inner rami twice the length of the peduncles; outer rami the shorter, about three-quarters the length of the inner. The peduncles of the 1st pair of pleopods carry each on the outer side 9 long plumose hairs, on the inner side 1 exceedingly long plumose hair and 2 small coupling-spines with recurved apices, the upper one (fig. 24) with 3 recurved teeth on either side, and the lower with only 2. The peduncles of the 2nd and 3rd pairs have only 1 or 2 long setæ on the outer side. The number of joints in the outer ramus is 11 in the 1st pleopods, 10 in the 2nd and 3rd; in the inner ramus 10 in the 1st, and 9 in the other pairs.

Uropods (fig. 25) extend backward to the same level; 1st and 2nd pairs much alike in construction. The peduncle of the 1st is as long as the inner ramus, with 3 or 4 spines on the upper curve (3 in the small specimen, 4 in the larger), and 1 curved spine underneath, and the falciform apical process reaching to half the length of the inner ramus; outer ramus the shorter, 1 spine inset on the upper margin, apex blunt with a cluster of 4 stout spines; inner ramus with a similar apical cluster and 2-3 along the upper margin. In uropod 2 the peduncle is not as long as the inner ramus; it equals the outer in length and carries 1 spine; rami as in uropod 1. In uropod 3 the peduncle is subequal to the rami in length, outer ramus, if anything, slightly longer than the inner, with a

cluster of setiform spines at the apex; inner ramus with 1 spine midway, and 1 spine and 2 setæ at the apex; the large animals have more spines; all the spines are short and stout, each with an apical filament. The outer ramus is 2-jointed, the terminal joint rudimentary, carrying 1 long serrate spine or bristle.

Telson (figs. 25 & 26) short, broader than long, depressed in the middle between the prominent lateral angles; apex rounded; 1 seta and 1 ciliated sensory hair on each angle, and a pair of small ciliated hairs on either side.

Colour described by Zaddach as "flavescens, dorso punctis nigricantibus sparso." In both his specimens and Norman's the colour has faded, but in Chevreux's it is still fresh and vivid. The whole animal is a beautiful golden yellow tint with stellate markings in dark brown. These markings extend over the whole dorsal surface of the head; the anterior margin of the 1st, and the posterior portions of the 3rd-7th pereon-segments and the 1st pleon-segment are banded with them. The 5th and 6th pleon-segments and the telson are entirely covered. An irregular band of brown runs along each side of the pereon just above the side-plates and is continued along the epimera of the pleon to the telson. All the side-plates and the posterior expansions of the basal joints of the hinder pereopods have each a patch of brown.

Distribution :—

GESERICH SEE, Prussia: and the BALTIC: Zaddach (53) as

L. pilosus, and (54) as *Protomedeia pilosa*.

BALTIC: Greifswalder Bodden, Müller (32) as *L. pilosus*.

BALTIC: Möbius (30) as *Leptochirus pilosus*, depth 1-10 fms.; bottom, zostera and ulva.

R. BURE, Norfolk, England: Norman (38) as *L. subsalsus*.

The BOSPHORUS: Sowinski (41) as *L. cornuaurei*.

Coast of ALGERIA: Chevreux (18) as *L. cornuaurei*.

LEPTOCHEIRUS PINGUIS Stimpson. (Plate XVIII. figs. 10-12.)

For synonymy see Stebbing, Das Tierr. pp. 627 & 738, and Norman (38) p. 309.

There is little to add to the summary of characters given by Stebbing. The few notes subjoined were taken from three slides kindly lent to me by Canon Norman, and prepared by him from specimens from Vineyard Sound and Long Island, N. America.

Head, ♀, lateral corners not much produced, truncate.

Superior Antenna.—1st and 2nd joints in ♂ and ♀ practically subequal to each other in length; 3rd a little more than one-third as long as 2nd. *Primary flagellum*, ♀, broken, 21 joints remaining, all, except the first 6, with a small sensory filament and short setæ; 6 very long joints in the *accessory flagellum* which equals 3 joints of the primary in length. In the male, the primary flagellum is composed of 31 joints, each, except the first 5, with a small sensory filament. The accessory is broken, 6 joints remaining, equalling 5 joints of the primary in length.

Inferior Antenna, ♀.—3rd joint short and broad, with 2 sensory spines on the upper distal angle; 4th joint the longest; flagellum longer than 5th joint, equal to 4th; 11-jointed in this specimen, each joint with a cluster on either distal angle of setiform spines and very long setæ.

Lower Lip, ♀, outer lobes rounded, densely setose; inner lobes coalesced, large, distally narrowed.

Mandible, ♀: *cutting-plate* on the right side produced below, margin divided into 4 rounded teeth, the lowest the largest; *accessory-plate* much as in *pectinatus*, tapering from the base to the long acute tip, with 2 very minute teeth above; 17 spines in the *spine-row*, the first 4 large, the last 2 very small. *Molar* prominent; crown reniform in shape, edged with strong teeth, and carrying a small accessory process on the side nearest the cutting-plate. *Palp*: 2nd joint longer than 1st; 3rd the longest, curved, falciform, attenuated distally, and armed as in the type species with 4 long stiff curved bristles apically, 2 dense rows of similar shorter bristles on the inner margin, and about 4 clusters on the outer margin. The left mandible was broken.

Maxilla, 1 ♀, much as in the type species; *outer plate* in one maxilla with 11 strong spines, 3 dentate ones at the upper angle, and the others set in pairs, 1 bifurcate and 1 dentate together; in the other maxilla there were 12 spines.

Maxilla, 2 ♀, as in *pilosus*; *inner plate* narrowed distally.

Maxillipeds, ♀, covered with numerous long setæ. The basal joints, and the 1st joint of the palp, on the outer side carry fan-shaped groups of exceedingly long plumose setæ; the outer side of the 2nd joint of the palp is also covered with them, and carries in addition a fringe along the inner margin. *Outer plate* expanded distally, densely fringed on the inner margin with slender spines, the apical ones of great length. *Inner plate* elongate, tapering distally to the narrow truncate apex; 3 flat spines are inset in the apex, almost hidden by the plumose setæ surrounding them; the outer margin is furnished with a row of about 10 simple setiform spines, and the inner carries a row of 18-20 very long, flexible, plumose setæ. The 2nd joint of the *palp* much the longest, much wider and about twice as long as the 3rd; the 3rd produced over the 4th as in the type species; 4th small, tipped with strong serrate spines.

First Gnathopod, ♀.—5th joint very long, provided on the posterior margin with transverse rows of feathered setæ, and the clusters of stiff serrate bristles found in all the species of the genus; 6th joint subequal to the 5th in length, as described by Stebbing; palmar margin convex, serrate. On the outer side, extending from the angle nearly to the middle of the palm, is a graduated row of bristles, 7 in number, similar in structure to those of the type species; a row of smaller bristles is inset submarginally along the palm. On the inner side, at the palmar angle, is a short, very broad, sensory spine, and a submarginal

row of about 17 very small bristles, like those of the outer side. The finger is exactly the length of the palm; being closed in the specimen examined, the detail could not be seen, owing to the palmar spines obscuring it.

This gnathopod in the male differs from that of the female, as in the type species. The 5th joint is longer in proportion; the 2nd and 6th joints shorter. The 5th joint equals the basal joint in length. The 6th is not quite two-thirds its length, and in the natural position is held bent almost to a right angle with the preceding joint. It is expanded distally; front margin very thick; hind margin laminar, convex on the upper surface, and furnished with six transverse rows of sensory setæ; palmar margin transverse, concave instead of convex, furnished with the submarginal rows of bristles along the margin, and the graduated group at the angle as described for the female; the very stout strong spine defining the angle is much larger than in the female. On the under side of the hind margin of the 5th joint (not the "basal joint" as given by Holmes (26) p. 522), distally, a chitinous spine-like process is developed; another similar but smaller one is on the 6th joint proximally, with a groove beside it, into which the larger one appears to fit when the hand is bent in. In order to show these processes, the hand is represented (fig. 10) with the hind margin uppermost, and, in consequence of being placed in this position, the true measurements of this joint cannot be seen; viewed from the side, it is exactly the same width proximally as the 5th, expanding gradually to the palmar margin. The finger in the male is much more arched than in the female, and when closed, the tip, instead of meeting the angle as in the female, impinges against the under surface of the hand; it is finely serrate, with a row of setules inset, and apparently a small auxiliary tooth near the apex, but this was too obscured by the overlying palmar bristles to be ascertained with any certainty.

Second Gnathopod (fig. 11) as figured by Norman. The finger is about half as long as the preceding joint, lightly curved, acute, of the same structure as in the type species; with 4 setæ on the inner margin, and a cluster of 3 subapically in the male; fewer setæ in the female.

Pereopod 5.—The finger is of unusual length, considerably longer than those of pereopods 1 and 2; very slender, almost straight, with a setule near the apex.

Uropod 3 (fig. 12), ♀.—A figure is given of the rudimentary 2nd joint of the outer ramus, with the spines omitted.

LEPTOCHEIRUS HIRSUTIMANUS Spence Bate. (Plate XVIII. figs. 13-16.)

The synonymy as given by Stebbing, *Das Tierr.* p. 627, omitting the references to Heller 1866, and Grube 1866, and adding:—*L. pilosus* Norman and Scott (36) p. 87.

The animal described by Heller as *Protomedeia hirsutimana* is

a female of *L. bispinosus* (p. 585): Grube's specimens proved on examination to be *pectinatus* (see p. 577).

Sars has given an excellent description and figures of this species, (40) pl. 197, to which it is only necessary to add one or two details.

Superior Antenna, flagellum furnished with very long sensory filaments.

First Gnathopod (fig. 13).—The palm is oblique, serrate, with its limit defined, as in *pectinatus*, by a large sensory spine inset on the under side. The tip of the finger reaches to this spine. The palm carries a small strong spine on the outer side, close to the insertion of the finger.

Second Gnathopod.—The finger (fig. 14) is exactly as in the type species, cf. Pl. XVII. figs. 17 & 18.

Hinder Peræopods.—Sars figures the finger of peræopod 5 only as bidentate, but the finger in all three hinder peræopods is of the same structure (see fig. 15). Spence Bate in his original description notes it for the 3rd peræopod, (1) p. 169; and Malm, (27) p. 546, describes and figures it for all three.

Uropod 3 (fig. 16).—The outer ramus is 2-jointed, as in all the other species of the genus, but the 2nd joint is exceedingly small and very difficult to observe except from the dorsal view, owing to the apex of the 1st joint being produced beneath it.

LEPTOCHEIRUS GUTTATUS Grube. (Plate XVIII. figs. 1–9.)

1864. *Protomedeia guttata* Grube (23) p. 63.

1866. " " " (24) p. 408, pl. x. fig. 3

1885. " " Carus (6) p. 417.

1886. *Ptilocheirus tricristatus* Chevreux (9) p. xl.

1887. " " " (10) p. 3.

1887. " " " (11) p. 310, pl. v. figs. 3 & 4,
and fig. 4 in the text, p. 578.

1888. *Leptocheirus guttatus* Stebbing (42) p. 366.

1898. " " Chevreux (15) p. 481.

1900. " " " (16) p. 92.

1906. " *guttatus* Stebbing (44) p. 629.

" *tricristatus* Stebbing (44) p. 629.

1906. " *guttatus* Norman & Scott (36) p. 85, pl. ix.
figs. 4–7.

1907. " *guttatus* Norman (37) p. 369.

1910. " *tricristatus* Chevreux (18) p. 2.

The specimens examined were:—

1 ♀, Grube's type specimen, 5.5 mm. long, from Breslau Museum.

3 ♀ *L. tricristatus*, taken by Monsieur Chevreux in the Bay of Quiberon, the largest measuring 4.5 mm.

9 taken by Canon Norman at Falmouth, the largest ♀ measuring 6.25 mm.

The type specimen from Breslau has Dr. Grube's original label

still on the bottle—" *Protomedeia guttata* Gr. m. Eiern, Lorenz, Val Cassione $\beta\beta$." It is a female, 5.5 mm. in length from the tip of the rostrum to the tip of the telson, with the pigmentation still vivid after 48 years in alcohol. I have described this specimen in detail, the account of the specific characters given by Grube not being sufficiently adequate for the present system of classification. In the figure of the whole animal it must be noted that as all the appendages were drawn *in situ*, the exact measurements and proportions of the joints of the peræopods cannot be expected. Each character is compared with Chevreux's specimens of *tricristatus* to prove the identity of the two forms.

Description.

Body (Pl. XVIII. fig. 1) more stoutly built than in *pilosus* and *pectinatus*, and sideplates shorter in proportion than in those species.

Head longer than the 1st and 2nd peræon-segments taken together; lateral corners not prominent, rounded.

Eyes round, black or brownish-black in colour; ommatidia large.

Sideplates 1-5 subequal to each other in length. Sideplate 1 not covered by sideplate 2; produced forward over the side of the head, of equal width throughout; inferior margin obtusely rounded, with 3 or 4 stiff, sparsely feathered setæ inset; hind margin, as in the type species, not continuous proximally. Sideplate 2 the largest, a little expanded distally, front angle and inferior margin rounded, hind margin straight; inferior margin fringed with a row of flexible, finely plumose setæ. Sideplates 3 and 4 alike in form, deeper than broad, slightly wider proximally; sideplate 5 with the anterior lobe about as deep as preceding sideplate, but not as wide; inferior margins of all three carry a few setæ, similar to those on sideplate 1. Sideplates 4 and 5 small.

Pleon.—Segment 3 much the largest, as long as segments 1 and 2 taken together. The 4th segment has the armature characteristic of this species: the posterior margin is produced in 3 processes, the median one upstanding, acute, shorter than the lateral ones; the latter broad at the base, much produced over the succeeding segments, apices acute, curving upwards, with a spinule inset in each. Segments 5 and 6 are small, the posterior margin of the 5th with a few setules dorsally. The hind margin of the 2nd epimeron is straight, with 1 crenulation and setule at the postero-lateral angle; inferior margin densely fringed with long plumose setæ. The hind margin of the 3rd is produced and rounded, with 2 indentations, a setule in each; inferior margin lightly concave, with 3 long plumose setæ inset midway, and 3 short spines near the antero-lateral angle.

ANTENNÆ. Superior Antenna (figs. 2-4).—1st joint of the peduncle stout, shorter than the 2nd; 3rd not quite half the length of the 2nd. *Primary flagellum* 7-12-jointed, the largest female had 11 joints; *accessory flagellum* 2-3-jointed. I must note here an occasional

curious variation in the number and proportions of the joints of the flagella in the same animal. This variation occurs, I believe, not infrequently in the Amphipoda, some species of *Jassa*, for example, having usually one joint more on one side than on the other. In Grube's type specimen the primary flagellum on the right side has 8 joints, 7 on the left; the right flagellum of the inferior antennæ has 4, while the left has only 3; the accessory flagella are both 2-jointed, but the one on the left antenna is longer than that on the right. Grube evidently counted the joints of the antennæ on the left side. In two other specimens examined, females of the same size, the superior antennæ were the same length, but in one case there were 12 joints, and in the other only 9; the accessory flagellum in both was 3-jointed, but whereas in the animal with 12 joints it exceeded the 2nd of the primary in length (fig. 4), in the other it did not reach to the level of the 2nd. Figures 2 and 3 are from another specimen, the right accessory of which had 2 joints, the left 3. All the joints of the primary, except the first 4, are provided with a sensory filament in addition to the setæ.

Inferior Antenna.—4th joint of the peduncle the longest; flagellum a little longer than the 5th, subequal to the 4th in length. *Flagellum* 3-6-jointed, the first the longest.

First Gnathopod (fig. 5).—Hand about twice as long as broad; palm oblique, defined, as in *pectinatus*, by a large sensory spine inset on the under surface; palmar margin convex, serrate, the serrations turning the corner and ending at the level of the spine, it carries 5 or 6 small sharp spines submarginally on the outer surface, and 8 smaller ones on the inner, all microscopically serrate. The finger is as long as the palm, curved, serrate, with 2 auxiliary teeth.

Second Gnathopod (fig. 6).—2nd joint very long, equalling in length joints 4-6 taken together. The 4th joint, as is usual in the genus, is much produced over the 5th on the inner side, and if the measurements are taken along this side, the 4th, 5th, and 6th are seen to be subequal to each other; Chevreux's figure (pl. v. fig. 4) shows the outer side. The finger is about three-fifths the length of the preceding joint, lightly curved, with 2 setules near the acute apex.

Pereopods 1 and 2 alike in structure, glandular, resembling the type species in the shape and proportions of the joints except that the 5th joint is slightly longer in proportion than in *pilosus*, and the finger is much longer and more slender, being equal in length to the posterior margin of the preceding joint.

Hinder Pereopods very like those of the preceding species, but stouter and much less elongate. Norman gives "the greatly produced last pereopod" as a specific character, but in most of the animals examined by me the proportions are much as figured in Grube's type specimen (fig. 1); in the others the 6th joint is more developed. The basal joint in all is large, rounded oval, produced downwards in a lobe, furnished anteriorly with short spines at intervals and ciliated hairs, and a dense cluster of the latter at the

distal angle; the posterior margins of the 3rd and 4th joints are crenulate, 6-9 crenulations each with a setule. In the 5th this margin has 5-7 serrations, and 1-3 ciliated hairs inset in the lobe. The 3rd joint carries a dense cluster of ciliated hairs at the anterior distal angle; and the 5th joint a similar cluster of feathered setæ. Fingers short and curved. In pereopod 3 the 4th joint is slightly longer than the 6th and wider; 5th shorter than 4th; 6th with groups of short spines. In pereopod 4, the 4th and 6th joints are subequal to each other in length; in one or two of the larger specimens the 6th is slightly the longer; it carries numerous spines and a cluster of very long setæ at the distal angle. In pereopod 5, the 4th, 5th, and 6th joints rapidly increase in length; the 6th is slender and lightly curved, inset on its posterior margin with exceedingly long setæ in addition to the spines.

Pleopods much as in *pectinatus*, except that the peduncles are shorter in proportion to the rami, about one-third as long, and the outer ramus is only two-thirds the length of the inner; cleft spines as in *pectinatus*, 5 in the 2nd pleopod; coupling-spines with 2 rows of recurved teeth in addition to the recurved apex, 3 teeth in a row in the lower spine, 2 in the upper.

Uropods (figs. 7 & 8).—There is a marked variation in the length of the uropods in different specimens, most noticeable in the 3rd pair, connected apparently with the variation in the development of the last pereopod. In Grube's specimen (fig. 8) the peduncle of uropod 3 is short and broad, shorter than the outer ramus; inner ramus not quite half the length of the outer. Some of Norman's and Chevreux's specimens are like Grube's type; in others, the peduncle equals the outer ramus in length and the inner ramus is nearly as long as the outer; while in the largest specimens with the last pereopods much produced, the peduncle of uropod 3 is longer than the peduncle of uropod 2, and longer also than the rami, both rami long and slender, inner quite equal to the outer in length. Uropod 1, peduncle shorter than outer ramus, the falciform process of unusual length, reaching almost to the tip of the outer ramus, furnished with 5 spines along the upper curve; outer ramus a little shorter than the inner, with 3 spines and an apical cluster of 5, 3 of which are longer than the others; inner ramus with 4 spines and a similar apical group; these spines are longer and more slender than those of uropod 2. Uropod 2 stoutly built, peduncle short and stout, with the falciform process equalling the outer ramus in length; outer ramus shorter than the inner, with 2 spines, inner with 3, each with an apical cluster of 5 strong stout spines (fig. 7). Uropod 3, peduncle produced underneath in a flat laminar expansion; outer ramus with a rudimentary 2nd joint carrying 1 long stiff sparsely feathered bristle; the 1st joint has a group of graduated similar bristles almost concealing the terminal joint; inner ramus slender, tipped with 1 stout spine. This description of uropod 3 applies to all the specimens examined by me.

Telson (fig. 9) as figured by Chevreux and Norman: the apical

margin is convex; from the dorsal view it appears truncate, cf. also *bispinosus* p. 589.

Colour.—Chevreux in his original description gives the colour as yellowish with some brown spots; in his later account he describes it as generally uniform yellow, some specimens with brown bands dorsally. In Grube's type the colour is still vivid, tawny yellow, with round stellate markings in light and dark reddish-brown. These markings occur on the head; in transverse bands on segments 2-10; on the sideplates; and on the posterior expansion of the basal joints of the hinder peraeopods.

Distribution:—

CHANNEL ISLANDS: Norman (37) p. 369, as *L. guttatus*.

FALMOUTH HARBOUR: Norman & Scott (36) p. 86, as *L. guttatus*.

Oceanic Coast of FRANCE: Chevreux (11) p. 311, as *Ptilocheirus tricristatus*, depth 7 m.; bottom deposit, gravel with coral-lines; (12) p. 578, depth 10 m., bottom deposit, nullipores; (15) p. 481, as *L. guttatus*, depth 10-50 m.

MEDITERRANEAN:—Coast of FRANCE: Chevreux (16) p. 92, as *L. guttatus*. Coasts of ALGERIA & TUNIS: Chevreux (16) p. 92, as *L. guttatus*; (18) p. 3. ADRIATIC: Grube (24) p. 408, as *Protomedeia guttata*.

LEPTOCHEIRUS PECTINATUS Norman. (Plate XIX.)

The principal references to this species are as follows:—

1864. *Protomedeia fasciata* (non Kröyer 1842), Costa (19) p. 155, pl. ii. fig. 8.
 1864. *Protomedeia* Kr.
 1864. *Leptocheirus pilosus* Grube (22) p. 73.
 1866. *Protomedeia hirsutimana*? Grube (24) p. 402.
 " *pilosa* Grube (24) p. 417, pl. x. fig. 2.
 1869. " *pectinata* Norman (34) p. 283.
 1887. *Ptilocheirus pectinatus* Chevreux (11) p. 309.
 1888. *Leptocheirus pectinatus* Stebbing (42) p. 1707 for references.
 1893. " *pilosus* Della Valle (21) pp. 427-430, pl. iv. fig. 10; pl. xii. figs. 1-14.
 1895. " " Walker (47) p. 470.
 1895. " " (48) p. 310.
 1899. " *dellavallei* Stebbing (43) p. 350.
 1900. " *pilosus* Chevreux (16) p. 90.
 " *fasciatus* Chevreux (16) p. 91.
 1906. " *dellavallei* Stebbing (44) p. 628.
 " *pectinatus* Stebbing (44) p. 629.
 1906. " " Norman & Scott (36) p. 87, pl. ix. figs. 1-3.
 " *fasciatus* Norman & Scott (36) p. 88, pl. v. figs. 11 & 12.
 1908. " *dellavallei* Norman (38) p. 310.
 " *pectinatus* Norman (38) p. 310.
 1909. " *pilosus* Walker (51) p. 341.

The specimens examined were:—

- 3 *L. pectinatus*, two females and one male, measuring 2·5–3 mm.; from Guernsey, sent by Canon Norman.
- 1 specimen, ♀, 4·5 mm., taken by the 'Huxley' in 109 fathoms, during her cruise on the north side of the Bay of Biscay, 1906.
- 3 *L. dellavallei*, ♂, 5–6 mm., from the coast of Senegal, from Monsieur Chevreux.
- 3 specimens from Breslau University Museum, referred to above. These latter specimens were sent in two bottles with Dr. Grube's original labels still on them. One bottle, marked "*Protomedeia pilosa* Zadd. ♀. Luss. picc. Mundtheile. Grube," contained two tubes, with one specimen in each. One of these, a female almost ready to moult, with a brood of young just hatched, was dissected, and is evidently the specimen from which Grube made his drawings. That this is so can be proved by a comparison of the figures with the dissections: *e.g.*, the shape of the 2nd maxilla in his figure is due to the fact that a portion of the inner plate with most of the feathered bristles had been torn away (*cf.* (24) pl. x. fig. 2 m¹, with fig. 10); and again, in the 1st maxilla he notes the absence of the apical seta, which seta is, however, there, but too completely masked by dirt to be seen, except under a high power. The other tube contained a female 5·5 mm. long. The second bottle was originally marked "*Protomedeia hirsutimana* Sp. B. ♀. Vollst. Luss. picc. Grube," but over the "*hirsutimana*" is written in a different ink "*pilosa* Zadd." and the words "*m. Eiern*" added, apparently by Grube himself. The tube in this bottle contains a large, brightly-coloured female, the largest specimen I have yet seen.

The specimens form a most interesting developmental series in the order in which I have arranged them above. Figures 14, 19, & 23 are taken from a female *pectinatus* 2·75 mm., figs. 1 & 13 from a male 2·5 mm. long, Norman's specimens: figs. 3, 16, 17, 25, & 28 are from the female specimen described by Grube: the other drawings are from two males, *dellavallei*, 5·25 and 6 mm. respectively, Chevreux's specimens. The *pectinatus* figures are more magnified than the others for the purpose of comparison.

Description.

Head not quite so long as pereon-segments 1 and 2 taken together; lateral corners not prominent, truncate.

Eyes almost round, a little drawn out towards the lateral angle; ommatidia few in number, large, with blackish-brown pigment in the centre, outer row not so darkly pigmented.

Sideplates (figs. 13–16).—The first sideplate, which has been the principal character for separating the two forms *pectinatus* and *dellavallei*, is of exactly the same structure in all the specimens. It is small, and completely hidden by sideplate 2.

(Through some mischance, Norman's figure of the first gnathopod ((36) pl. ix. fig. 2) shows the *second* sideplate attached instead of the first.) The first sideplate is subquadrate in the young animal, with 1 long sensory spine inset at the anterior angle, but with growth this angle becomes more produced downwards, until in the largest specimen of all the anterior margin of the sideplate is half as long again as the hind margin. Four stages of development are represented in the figures. The 'Huxley' specimen forms the link between figs. 14 & 15; the anterior angle is not so much produced as in the latter, 6 setules are inset anteriorly, 1 inferiorly, and 3 short sensory hairs at the posterior angle. In Grube's specimens, the anterior margin is lightly concave and the posterior angle has a strong chitinous margin. The hinder portion of the sideplate is firmly affixed to the basal joint beneath, so firmly in fact as to make it impossible to separate them without destroying the shape of the sideplate. A delicate laminar plate extends beyond the sideplate behind, and is all but continuous with it proximally, the line of demarcation being barely distinguishable. Sideplate 2 is the largest of all, as deep as broad in the small specimens, a little deeper than broad in the fully developed animal; front margin rounded; hind margin almost straight with 4 small setæ inset; inferior margin rounded, thickly fringed with delicate, sensory, cleft-tipped setæ of varying lengths (26 in the young, to about 41 in the full-grown). The remaining sideplates are very like those of the type species. Sideplates 3 and 4 are subequal to each other in length, shorter than the 2nd, about half as deep again as broad. The 3rd is of equal width throughout, front and hind margins straight, the latter with three or four setæ inset; inferior margin convex, fringed with 10-19 of the sensory cleft setæ. The 4th is a little wider proximally than the 3rd, and the front margin is lightly convex; inferior margin with fewer sensory setæ, 5-15. In sideplate 5 the anterior lobe is about as broad and as deep as the preceding sideplate; inferior margin rounded, with only 4-7 setæ; posterior lobe very small, only one-third the depth of the anterior, 2 small setæ inset. Sideplate 6 small; posterior lobe about half as deep as the anterior, with 1 small seta behind and 1 of the sensory serrate spines similar to those found on the hinder pereopods and uropods (see fig. 21); on the anterior lobe are 2 ciliated hairs. Sideplate 7 small and subquadrangular.

Pleon.—Segment 3 much the longest, as long as the 1st and 2nd taken together; 4th segment a little depressed dorsally. The hind margin of the 2nd is straight, that of the 3rd rounded; inferior margins of 1-3 thickly beset with long plumose setæ, most numerous on the 2nd. On either side of the median line of the 4th and 5th segments the posterior margin is produced in an erect membranaceous lappet-like process, too delicate in structure to be termed a tooth, each process having a setule inset in the notch (fig. 26). Both Costa and Grube refer to these setules,

without apparently noticing the processes*, but this oversight is very easily understood. The integument is so thin that if by any chance, such as pressure or a little mucous dirt collected, the process be flattened against the body, it is impossible to see it. The 4th segment has a group of spines on either side, just above the insertion of the uropods. The processes on the 5th segment extend beyond the very small 6th segment.

ANTENNÆ. *Superior Antenna* (figs. 1-3).—1st joint of the peduncle stout, slightly longer than the 2nd in actual measurement, the greater apparent length of the latter being due to its slenderness; in only one of the specimens, Grube's largest, the 2nd joint was a very little longer than the 1st; on the outer side are several small ciliated hairs, and a cluster of setæ with 1 long ciliated hair at the distal angle; the inner angle carries a very long, stout, outstanding sensory spine with 2 smaller ones inset beside it. The 2nd joint is only half as broad as the 1st, with a cluster of 3 or 4 setæ and 1 long ciliated hair on either distal angle. The 3rd joint in all the large specimens I have examined barely reaches half the length of the 2nd; in the smallest one it slightly exceeds half the length. The *primary flagellum* is composed of 9-14 joints; one young ovigerous female 2.5 mm. long had 9 joints; a male measuring 6 mm. had 14; Grube's large females 5.5 mm. and 6.25 mm. had respectively 12 and 10, the joints in the last-mentioned case being longer than in the other animals examined. Each joint, from the 4th in the full-grown and from the 2nd in the young, to the penultimate, is provided with a very long sensory filament in addition to the small setæ. The *accessory flagellum* is usually 2-jointed, equalling the 1st joint of the primary in length, and is so described by Norman, Della Valle, and Walker. All the specimens examined by me, except one, agree in having 2 joints only, though the length varies a little, in the small specimen (fig. 1) being slightly less than the 1st joint of the primary in length, and in the medium-sized specimen (fig. 2) slightly more. The exception is Grube's largest specimen, which has 10 joints in the primary, and a 3-jointed accessory flagellum equalling the first 2 joints of the primary in length. Costa's observation agrees with this, (19) p. 155, "Il filetto composto di dieci articoli finamente pelacciuti; il filetto accessorio lungo appena quanto due articoli del primario." Grube in his description, (24) p. 403, says: "Bei dem von mir zuerst untersuchten Exemplar fehlte den oberen Antennen die Nebengeißel. . . . An einem zweiten Exemplar fand ich die Nebengeißel und zwar eine 3-gliederige." The first specimen examined by him (from Lussin-piccolo) had, however, an accessory flagellum, a 2-jointed one, but this, in both antennæ, had lost the

* "Quelli del quarto [abdominal segment] in oltre guerniti di piccole spine lungo il margine dorsale." Costa (19) p. 15.

"Auf dem Rücken des 11ten und 12ten Segments vor dem Hinterrande sieht man ein paar Borsten." Grube (24) p. 407.

long apical setæ, and, lying flat against the primary, was hidden by a coating of dirt. In his third specimen both the superior antennæ are missing.

Inferior Antenna.—3rd joint of the peduncle short, as broad as long, with a cluster of very long setæ on the inner angle and 1 long sensory spine above. The 4th joint is twice the length of the 3rd, slightly longer than the 5th, both beset with clusters of the long, cleft-tipped setæ and smaller setiform spines. *Flagellum* shorter than the 5th joint, composed of 4 joints, the 1st much the longest, almost equalling in length the two following taken together, each carrying, in addition to the setæ, a pair of strong spines setting out on either side. In the small specimens the flagellum is 3-jointed.

ORAL PARTS.—The description is taken from the fully adult specimens 5–6 mm. long, but the structure is precisely the same in the small animals, the only difference being the lesser number of spines and setæ.

Upper Lip (fig. 4) thick, subquadrate in form, much arched above; apex emarginate, slightly asymmetrical. In the figure the lip is turned a little upwards to show the emargination of the apex.

Lower Lip (fig. 5) as in the type species.

Mandibles (fig. 6).—*Cutting-plate* on the right mandible curved, margin divided into 3 teeth, the lowest much produced; in two specimens the margin was entire, the middle tooth not being developed; *accessory-plate* narrow, in some specimens scarcely wider than, and not as long as, the 1st spine of the spine row, produced below to an acute tooth covered with microscopic tubercles, and provided with a small tooth above. In the left mandible the *cutting-plate* has 4 teeth, the second small, the lowest the largest; the *accessory-plate* is strong, much broader than that of the right mandible, the mandible divided into 3 teeth, the upper and lower of which are large, the middle one small. There are 7 spines in the *spine-row* in Chevreux's specimens, 8 in Grube's largest, the first 3 being unusually large, wide at the base, flat and furry in appearance owing to being covered with microscopic spinules. The *molar* is very prominent; the crown transversely ridged with rows of teeth, edged with flat spinules, with 1 long, feathered seta above. The *palp* is very large; 3rd joint the longest, tipped with long serrate bristles, with a double row of smaller ones extending down the distal half of the inner margin; the outer margin has 4 groups of long serrate bristles inset.

Maxilla 1 (figs. 7–9).—*Inner plate* large, with 1 long plumose seta inset; Grube notes the absence of this seta (p. 404), but his specimen is so covered with mucous dirt as to render it difficult to see details clearly; not only is the seta present, but the new one can be seen under the old loose skin, the animal, as before stated, being ready to moult. *Outer plate* curved, with 11 strong spines, 4 of which are bifurcate (fig. 8), the rest

finely dentate (fig. 9); the outer margin is covered with fine hairs. The 2nd joint of the *palp* is expanded apically, and rounded, with a marginal row of 4 strong flat spines, and 3 plumose setæ; 2 or 3 diagonal rows of setæ are inset submarginally.

Maxilla 2 (fig. 10).—*Outer plate* the larger, covered with exceedingly fine long hairs; expanded distally, bulging behind, furnished with an apical cluster of stiff bristles, and a row of sparsely plumose setæ extending some distance down the inner margin. The *inner plate*, distally narrowed, is provided with 2 rows of setæ; one row, submarginal, consists of 20 long, delicate, finely plumose setæ; the second row contains an apical cluster of stiff setæ, with 8 inset along the margin, these latter of the same structure as the plumose ones of the outer plate. In Grube's specimen the upper portion of the inner plate has been torn away; the 2 apical setæ represented in the figure 2 m¹ are two of the plumose row of the outer plate.

Maxillipeds (figs. 11 & 12).—*Inner* and *outer plates* well developed, but narrow. The apices of the *inner plates* are inset with 4 long, feathered, setiform spines along the margin, with a group at the inner angle of 4 long delicate plumose setæ set together in a little hollow, 3 similar ones extending down the inner margin, and 2 submarginally on the outer side. The outer surface is longitudinally ridged. On this surface close to, but just below, the inner angle, is a small *coupling-spine* (fig. 12), stout, and bent upwards. It appears to be tuberculated on its inner side, but the detail is obscure, even with a $\frac{1}{12}$ th oil-immersion lens. The *outer plate* carries a marginal row of flat feathered spines (15 in Grube's large specimen, 13 in Chevreux's, 7 in the smallest of all), the 2 apical ones much the longest, and submarginally on the outer side a few long feathered setæ. The 2nd joint of the *palp* is the longest, in Grube's specimen twice the length of the 1st, furnished with numerous plumose setæ; the 3rd is produced over the insertion of the finger as in the type species; finger small, obtuse, carrying apically 1 long stout dentate spine, 1 smaller one, and 2 setæ in Chevreux's specimen, 3 stout spines and 4 setæ in Grube's, 1 spine and 2 setæ in Norman's.

First Gnathopods (figs. 13, 15, 17, & 18).—2nd joint narrow at the base, but widening distally; posterior margin convex, with 2-4 very long delicate setæ inset midway; anterior margin straight, carrying a row of delicate plumose setæ, another row of longer similar setæ is found on the under surface as in the type species; 3rd joint bulging behind, fringed with numerous closely set long feathered setæ; 4th joint the smallest, also fringed posteriorly with feathered setæ shorter than those of the 3rd. The 5th is considerably longer than the 6th, with 5-7 transverse rows of plumose setæ, and 5-7 clusters of rigid serrate bristles along the hind margin. 6th oblong, about twice as long as broad, with 4-5 transverse rows of setæ on the hind margin; palm short,

truncate. The long spine on the hind margin in Chevreux's figure, (16) pl. xi. fig. 2 *a*, is the longest of a group of 3 inset on the under side of the hand, and projecting beyond the hind margin. The palmar margin is mentioned by Chevreux (p. 91) as affording a distinguishing character for the two forms—concave for *pectinatus*, and convex for *dellavallei*,—but an examination of a series of specimens shows conclusively that this difference is due to sex. In the male (figs. 15 & 18) the margin is concave, and the palmar angle forms a right angle with the hind margin; in the female (fig. 17) the palmar angle is rounded, the curve commencing at the insertion of the finger, and merging imperceptibly into the hind margin. The palm is strongly serrated in all; in the female the serrations turn the corner and reach as far as the large spine just referred to. The palmar spines are of the same structure as those of the type species. The finger is more than twice the length of the palm (a little longer in proportion in the young form), curved, with a strong auxiliary claw; a long, stiff, finely serrated spine and 1 setule are inset in the notch, 1–2 setules behind the claw; the rest of the inner margin is firmly serrated.

Second Gnathopod (figs. 19 & 20) as described by Grube, Norman, and Della Valle. Figures of the finger, so characteristic of the species, are given from Norman's and Chevreux's specimens in order to show the identity of the two forms *pectinatus* and *dellavallei*. Grube's specimens agree exactly with these. In the young form the finger is slightly longer in proportion to the preceding joint than in the older animals, not equalling quite half its length in Norman's specimens, and only about one-third the length in Grube's largest.

Peræopods 1 and 2 glandular, alike in structure; 2nd joint large, fringed posteriorly with long delicate setæ, more numerous on the 2nd peræopod; anterior margins with from 4–6 similar setæ: 4th joint about half the length of the 2nd, slightly expanded distally; 5th joint narrower and shorter than 4th; 6th joint slightly longer than the 4th; the two terminal joints tapering gradually to the acute tip of the 7th; the 7th subequal to the 6th in length, with the glandular aperture opening at the tip.

Hinder Peræopods (fig. 21) more strongly built than the preceding; rapidly increasing in length. Peræopod 3: 2nd joint large, a little longer than broad, equalling in length the 3 following joints taken together; both margins convex, the anterior beset at intervals with 7 small sensory spines, the first 3 unaccompanied by setæ, the 4th with 1 seta, the 5th with 2, 6th with 3, and the distal one with 4; posterior margin produced below in a rounded lobe, crenulate, 6 of the crenulations with setules inset, the 2 crenulations on the lobe each with a ciliated hair; 3rd joint short and broad, with a cluster of setæ, 1 ciliated hair, and 1 spine; 4th joint half the length of the 2nd, stout, slightly expanded anteriorly, with the spines of the structure peculiar to the hinder peræopods and uropods (fig. 21); 5th joint

shorter than 4th, with two clusters of spines on either side; 6th about as long as the 4th, but much more slender, spinose, with groups of spines on either side and 1 very long stout spine inset behind the finger. Finger short, not half the length of the preceding joint, much curved, with 2 specialised bristles towards the apex, one on the inner side lying flat against the finger and reaching to the apex, and the other on the outer side, setting out at right angles to the finger. This one appears to have a flattened tip, and the inner one to be feathered, but the detail is almost impossible to see owing to their extreme tenuity and the angle at which they are placed. Peræopod 4 is noticeable for the great length of the spines of the 5th and 6th joints; 2nd joint rounded oval, produced behind into a rounded lobe, 8 spines along the anterior margin, the distal 5 accompanied by increasing clusters of ciliated hairs and setæ; posterior margin with 10 crenulations, and a submarginal row around the lobe of 5-8 ciliated hairs; 4th and 5th joints practically subequal to each other in length, 5th narrower than 4th; 6th considerably longer and more slender; the spines on this joint are longer than those on the 5th, 4 clusters increasing in length and number, on either side, 2 of the clusters behind the finger equalling the joint itself in length; they are very brittle, several of the specimens not having a single perfect one remaining. Finger lightly curved, of the same structure as the finger of the preceding peræopod. Peræopod 5: 2nd joint narrow proximally, widened distally; the proximal end of the posterior expansion is produced subacutely, the distal end, as in peræopods 3 and 4, forms a rounded lobe; on the posterior margin are 8 crenulations with a setule on each, and 20 ciliated hairs in a submarginal row; the anterior margin has 8 spines as in peræopod 4, and 3 long fine hairs proximally. The 4th-6th joints rapidly increase in length and decrease in width; 4th and 5th each beset with 3 groups of stout spines on either side; 6th twice the length of the 4th, with 5 groups of spines on either side, the terminal posterior group of spines and setæ of extraordinary length. Finger as in peræopod 4.

The smaller specimens agree in all details with this description, the only difference being the lesser number of spines.

Pleopod 1 (fig. 22): peduncle short, hardly half the length of the outer ramus, with about 10 long plumose setæ on the outer side; 2 small coupling-spines, and 1 long plumose seta inset together on the inner. The outer ramus 12-jointed, considerably shorter than the inner; inner ramus 14-jointed, with 4 cleft spines. Pleopods 2 and 3 alike; peduncle more than half the length of the outer ramus, with only 2 or 3 fine hairs. The rami are shorter than in the 1st pleopod; outer ramus with 11 joints; inner with 13; 4 cleft spines in the 2nd pleopod; 2 in the 3rd.

Uropods (figs. 23-26) extend backwards to the same level. The peduncle of uropod 1 is shorter than the outer ramus, with 5 slender spines on the upper curve, and 3 inset diagonally midway on the outer surface; the falciform apical process reaches to half

the length of the outer ramus. The outer ramus is shorter than the inner, both furnished with slender spines. In uropod 2 the peduncle is almost as long as the outer ramus; outer ramus the shorter; the spines are shorter and stouter than those of uropod 1. I have figured uropod 3 in detail (figs. 23, 24, & 25), because it has been used by Norman (36, p. 89) as distinguishing the two forms. A comparison of the figures will show the identity of structure. The outer ramus has a minute apical joint carrying a long rigid spine, this joint being larger in proportion in the young form; the detail of the spines in the small specimen (fig. 23) could only be seen with the $\frac{1}{12}$ th oil-immersion.

The *Telson* (figs. 27 & 28) is of exactly the same structure in all the specimens; lateral angles greatly elevated, each produced to an acute point, each with 1 long spine and 1 short sensory ciliated hair on the margin, and 2 ciliated hairs underneath. The subacute apex curves upwards also, but not to the same degree as the lateral angles. Figure 27 is taken from Chevreux's specimen; in two of Grube's, the tip was as represented in fig. 28, in the third, the largest, it was as in fig. 27.

Colour.—Grube's largest specimen still retains its vivid colour, a yellowish tint, with markings in dark brown. The distribution of the pigment agrees perfectly with Costa's figure (19) pl. ii. fig. 8. The markings are composed of cloudy brownish patches stippled thickly but irregularly with blackish-brown spots. The dorsal part of the head is covered with dark brown pigment, shading into black near the eyes, these dark patches causing the eyes to appear larger than they really are. The 1st peræon-segment is plain; the 2nd has only faint patches, one on the back, and one on each side; the 3rd and 4th with their corresponding sideplates, and the 5th are thickly covered with the pigment, arranged in a band along the middle of the segment; the 6th is plain; the 7th and the first 3 pleon-segments with their epimera are darkly pigmented; the 4th pleon-segment has a faint patch on each side; the rest of the animal is plain. The general effect is very striking, the animal showing a dark head, 3 dark rings anteriorly, and 4 farther back. The amount of colour probably varies with the locality. Walker, (48) p. 310, describes it as "deep yellow, with transverse brown lines on all the segments."

Distribution.—This species has a very wide distribution:—

SHETLAND ISLES: Norman (34) p. 283, as *Protomedeia pectinata*; dredged; St. Magnus Bay, deep water.

IRISH SEA: Walker (48) p. 310, as *Leptocheirus pilosus*; dredged; 17 fathoms.

W. & S. COASTS OF IRELAND: Walker (50) p. 169, as *Leptocheirus pilosus*; 40 fathoms; bottom deposit, gravel.

CHANNEL ISLANDS: Walker & Hornell (49) p. 54; as *Leptocheirus pilosus* Zadd.=*L. pectinatus* Norman; 7 fathoms; bottom deposit, gravel, clinkers, and shells. Chevreux (16)

p. 91, as *Leptocheirus pilosus*; tidal zone; bottom deposit, rather coarse sand. Norman (37) p. 369, as *Leptocheirus pectinatus*.

FRANCE: OCEANIC COAST: Chevreux (11) pp. 290, 309, as *Ptilocheirus pectinatus*; 10-19 m.; bottom deposit, nullipores and mud. Chevreux (15) p. 482, as *Leptocheirus pilosus*; 10-20 m.

BAY OF BISCAY: ss. 'Huxley,' 47° 48' N.; 7° 46' W.; 109 fathoms.

MEDITERRANEAN: Chevreux (16) p. 91, as *Leptocheirus fasciatus*.

PROVENCE: coast of ALGERIA: CORSICA, dredged in 12 fathoms: Chevreux (17) p. 4, as *Leptocheirus fasciatus*.

BAY OF NAPLES: Costa (19) p. 155, as *Protomedeia fasciata*. Della Valle (21) p. 430, as *Leptocheirus pilosus*; 10-20 m.; bottom deposit, sand.

ADRIATIC: Grube (22) p. 73, as *Protomedeia pilosa*. Grube (24) p. 403, as *Protomedeia hirsutimana*? and *Pr. pilosa*.

SENEGAL: Chevreux (in litt.).

WASIN, BRIT. E. AFRICA: Walker (51) p. 341, as *Leptocheirus pilosus*; 10 fathoms; bottom deposit, mud.

LEPTOCHEIRUS BISPINOSUS Norman, (Plate XVIII. figs. 17-20. Text-fig. 146.)

1866. *Protomedeia hirsutimana* Heller (25) pp. 34 & 35.

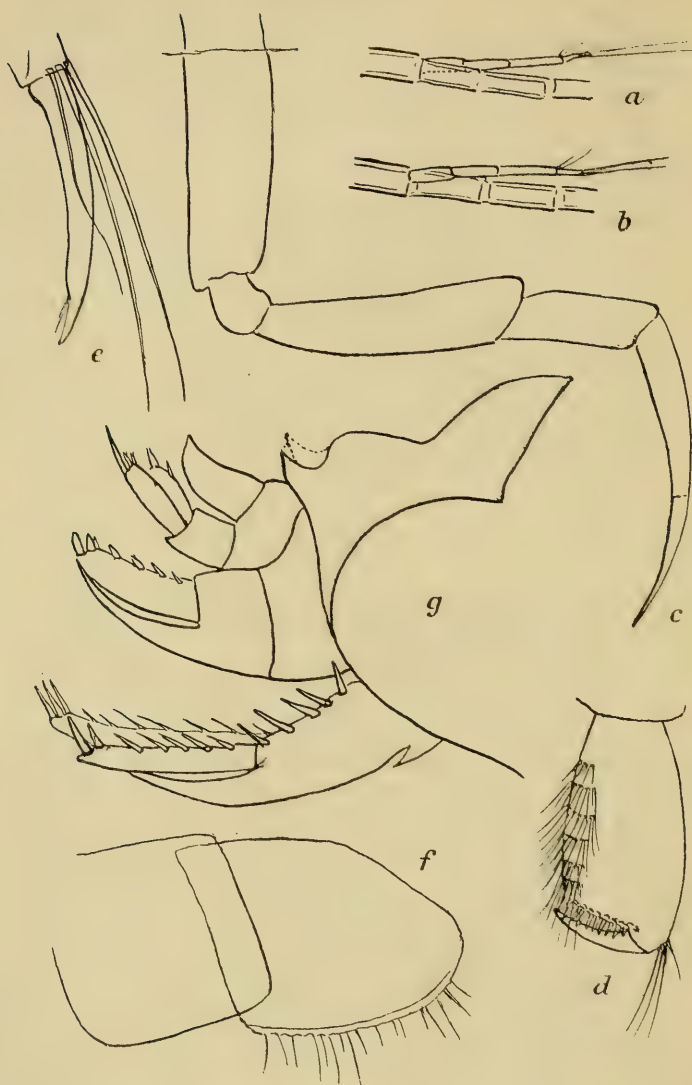
1893. *Leptocheirus guttatus* Della Valle (21) p. 430, pl. xii. figs. 15-24.

1908. *Leptocheirus bispinosus* Norman (38) p. 308, pl. xii. figs. 7-9; pl. xiii. figs. 1-3.

The specimen described by Heller as *Protomedeia hirsutimana* Sp. Bate is preserved in the Hofmuseum, Vienna. The description and figures of it, most kindly sent to me by Dr. Pesta, prove it to belong to the same species as described by Norman in 1908 under the name of *L. bispinosus*.

The *guttatus* of Della Valle, in my opinion, must also be included in this species. A comparison of the two accounts, Della Valle's and Norman's, leaves no room for doubt. The only point of difference is in the number of joints in the accessory flagellum: Della Valle gives the number as 2, subequal in length, and as long, taken together, as 2 joints of the primary flagellum; Norman as 5, as long as 3 joints of the primary. It seems probable, either that Della Valle had a young specimen before him with only two joints developed, or, what I think more likely, that the accessory flagellum was broken. In the other specimens of this species (and, indeed, in all the specimens of this genus that I have examined) the terminal joint of the accessory flagellum is very small and tipped with long setæ, but Della Valle says definitely that the 2nd joint in his specimen was equal in length to the 1st, and in his figure he shows only 2 small setæ instead of the usual long apical cluster. I have added below some details to the description given

Text-fig. 146.

*Leptocheirus bispinosus* Norman.

The figures were drawn by Dr. Otto Pesta from Heller's specimen
in the Hofmuseum, Vienna.

- Fig. a. Superior antenna, accessory flagellum, left side, $\times 100$.
 Fig. b. " " " " right side, $\times 100$.
 Fig. c. First pereopod, $\times 60$. Fig. d. " Hand of first gnathopod, $\times 100$.
 Fig. e. Finger of second gnathopod, $\times 200$. Fig. f. Sideplates 2 and 3, $\times 60$.
 Fig. g. Pleon-segments 3-6, $\times 60$.

by Canon Norman for the sake of a more complete comparison with Della Valle's account.

The species resembles *guttatus* Grube in many respects, the principal distinguishing points being:—the proportions of the antennæ; the hand of gnathopod 1; sideplate 2; the shape of the basal joints of the hinder pereopods; the armature of the pleon; and uropod 3.

Description (taken from the type specimen of *bispinosus*, a female, which Canon Norman kindly allowed me to examine):—

Head longer than peræon-segments 1 and 2 taken together; lateral corners rounded.

Eyes very large; pigment brownish black; ommatidia large.

Sideplate 1 free of sideplate 2, about half its width, but not equalling it in length, a little expanded distally and fringed with long setæ. Sideplates 2-5 much as in the type species for shape. The 2nd is the largest and deepest, much deeper than the corresponding body-segment; expanded inferiorly, hind margin straight, inferior margin rounded and fringed with numerous plumose setæ (*cf.* text-fig. 146, *f*, with Norman's pl. xiii. fig. 2 and Della Valle's pl. xii. fig. 17). The 3rd is deeper than the 4th; and the 4th a little deeper than the 5th; all fringed inferiorly with setæ.

Pleon.—Segment 3, hind margin produced, rounded, crenulate; crenulations 8 in number, each with a setule; inferior margin concave, furnished with numerous strong sensory spines submarginally. Pleon-segment 4 as described by Norman, with "a strong and acute angular backward projection on each side"; Dr. Pesta's account agrees with this, "das 4. Pleonsegment hat 2 seitliche nach aufwärts geschwungene 'angles'" (text-fig. 146, *g*); Heller erroneously notes them as occurring on the 5th. The 5th, indeed, carries 2 dorso-lateral angles (as stated by Della Valle), but these are exceedingly small and difficult to see *in situ*, not much produced, acute, each with a seta inset behind.

ANTENNÆ (text-figure 146 *a, b*).—*Superior Antenna*, as figured by Della Valle: 1st joint of peduncle shorter and broader than the 2nd, carrying a stout spine on the inner distal angle; 3rd a little more than one-third the length of the 2nd; *primary flagellum* with 16 joints, each, from the 3rd, with a small sensory filament; Dr. Pesta says of Heller's specimen that the number of joints on the right side is 17, on the left 18. The *accessory flagellum* in Norman's specimen extends to the 3rd joint of the primary, 5-jointed, the first 4 joints subequal to each other in length, the terminal one minute, tipped with long setæ; in Heller's specimen it does not reach to the distal margin of the 3rd joint of the primary, "4-gliedrig, jedoch ist das Endglied rechts kürzer als links."

Inferior Antenna: 4th joint longer than 5th; flagellum about the same length as the 5th, composed of 7 joints, the first as long as all the others taken together.

First Gnathopod (Pl. XVIII. fig. 17): 3rd and 4th joints more densely setose than in the other species, the plumose setæ being

arranged in transverse rows in addition to the marginal fringe. 5th joint slightly longer than 6th; 6th twice as long as broad, widening a little towards the palm. The palmar margin is convex, its limit defined, as in the preceding species, by a long sensory spine inset on the under surface; on the outer surface it carries a submarginal row of about 10 strong sensory spines, and on the inner side a thick row of setiform spines. The finger when closed reaches to the large spine; it is curved, with a strong auxiliary tooth subapically, and 6 smaller teeth on the inner margin, each tooth with a setule beside it. In the notch near the apex 2 or 3 longer setules are inset.

Dr. Pesta's description is as follows (text-fig. 146, *d*): "das Handglied des 1. *Gnathopoden* ist vorne etwas verbreitert, die Klaue so lang wie die konvexe Seite desselben; der konvexe Rand die 'Hand' besitzt eine Reihe von kräftigen Dornen, die gegen die Klaue gerichtet sind."

Second Gnathopod (fig. 18): 2nd joint unusually long, equalling in length the joints 3-6 taken together; 3rd, 4th, and 5th joints subequal to each other measured along the inner side. The finger is nearly straight, about half the length of the preceding joint; "leicht gebogen und spitz" (text-fig. 146, *e*).

Peræopods 1 and 2.—The length of the 4th joint forms a distinguishing character for this species. The peræopods are about the same length, but in peræopod 1 the basal joint is longer than in peræopod 2; and the 4th joint is longer in the latter than in the former, being equal to the basal joint in length. Dr. Pesta says "das 4. Glied des 1. *Peræopoden* ist länger als das 6. Glied und fast so lang wie das 2. Glied." (*Cf.* text-fig. 146, *c*, with Norman's pl. xii. fig. 8 and Della Valle's pl. xii. fig. 24.) The 2nd joint carries posteriorly numerous delicate sensory setæ, some of great length; 4th joint long, of equal breadth throughout; 5th about half as long as the 4th; 6th longer than 5th, both with clusters of long sparsely feathered setæ posteriorly; finger shorter than the 6th, subequal to the 5th in length, with the glandular aperture opening at the tip.

Hinder Peræopods (fig. 19) as figured by Della Valle. In peræopod 3 the basal joint has the posterior margin straight and crenulate; in peræopod 5 the posterior expansion of this joint is much wider distally than at the base, and the margin is rounded and serrate, the lower portion carrying numerous plumose setæ. Fingers curved and falciform. In Heller's specimen, peræopod 3 is missing, but Dr. Pesta says of the last two pairs "die Endklauen sind einfach (nicht 'bifid')," as in Spence Bate's *hirsuti-mana*. In Norman's figure, pl. xii. fig. 9, the terminal joints are lying in such a position as to quite conceal the spines. I have therefore refigured them to show the armature.

Uropods 1 and 2 (text-fig. 146, *g*) much as in *guttatus* Grube; very spinose, the spines of uropod 2 shorter and much stouter than those of uropod 1. The falciform process of the peduncle reaches, in uropod 1, to the tip of the outer ramus; in uropod 2 beyond the tip. The inner rami differ from the other species in having

slender, feathered setæ, or setiform spines, in addition to the other spines. These are found on the under margin, 3 in uropod 1, short, inset at intervals, and 2 clusters of long ones in uropod 2, near the apex. In uropod 3 (fig. 20) the outer ramus is furnished with an apical cluster of 5 spines and 3 or 4 long feathered setæ similar to those of the 2nd uropod, and 1 cluster of small spines midway, in Norman's specimen (2 clusters figured by Della Valle, probably from an older specimen); the inner ramus is tipped with 1 stout spine and 1 seta, with 1 spine midway, in Norman's specimen (2 in Della Valle's).

Telson.—The apical margin of the telson is represented in Della Valle's figure as truncate, but, as in *guttatus* Grube, this appearance is due to the angle at which it is carried. The margin is really convex, but as in the natural position it is a little bent in under, the convexity is not apparent from the dorsal view.

Colour given by Della Valle as greyish yellow without markings; by Dr. Pesta as "gelbbraun, Auge schwarz"; but, he adds, "diese Färbung dürfte nicht natürlich sein."

Distribution :—

BAY OF BISCAY: Norman (38) p. 309, as *L. bispinosus*, depth 35-60 fathoms.

NAPLES: Della Valle (21) p. 432, as *L. guttatus*; bottom deposit, corallines.

ADRIATIC at Lesina: Heller (25) p. 35, as *Protomedea hirsutimana*.

GULF OF BÔNE and Coast of TUNIS: Chevreux (18) p. 3, as *L. bispinosus*.

The only details given by Catta concerning his species *massiliensis*, viz. the nature of the ground on which it was captured "fonds coralligènes," and the colour, "un beau jaune, tandis que l'œil était complètement noir," would seem to point to *L. bispinosus*.

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EXPLANATION OF THE PLATES.

PLATE XVII.

Leptocheirus pilosus Zaddach.

Fig. 1. Whole animal, Zaddach's specimen, young ♀	×	42.
2. Superior antenna, seen from above, young ♀. Zaddach's specimen.	×	50.
3. Part of inferior antenna..... " " " "	×	50.
4. Upper lip..... " " " "	×	95.
5. Lower lip..... " " " "	×	95.
6. Mandible..... " " " "	×	95.
7. Maxilla 1'..... " " " "	×	95.
8. Maxilla 2..... " " " "	×	95.
9. Maxillipeds..... " " " "	×	95.
10. First gnathopod..... " " " "	×	50.
11. Hand of the first gnathopod. ♀. Norman's specimen	×	50.
12. " " " " ♂. Chevreux's	×	50.
13. Finger of first gnathopod. Large ♀ " "	×	95.
14. " " " " ♂ " "	×	95.
15. Serrate bristle from 5th joint, first gnathopod. Large ♂. Chevreux's specimen.	×	175.
16. Second gnathopod. Young ♀. Zaddach's specimen	×	50.
17. Finger of second gnathopod. Young ♀. Zaddach's specimen	×	140.
18. " " " " ♀. Norman's	×	140.
19. First peræpod. Young ♀. Zaddach's specimen	×	50.
20. Second " " " " " "	×	50.
21. Third " " " " " "	×	50.
22. Fifth " " " " " "	×	50.
23. Fifth peræpod, under surface. Large ♂. Chevreux's specimen	×	40.
24. Upper coupling-spine, first pleopod. Young ♀. Zaddach's specimen.	×	290.
25. Telson and third uropods, dorsal view. " " " "	×	50.
26. Telson, lateral view. Young ♀. Zaddach's specimen	×	50.

PLATE XVIII.

Fig. 1. Whole animal. Grube's type specimen ... <i>Leptocheirus guttatus</i> .	×	20.
2. Accessory flagellum, right antenna. Norman's specimen	"	75.
3. Accessory flagellum, left antenna. Same specimen	"	75.
4. Accessory flagellum, right antenna. Another specimen, ♀	"	75.
5. Hand and finger, first gnathopod. Chevreux's specimen, ♀	"	75.
6. Finger of second gnathopod. Chevreux's specimen, ♀	"	75.
7. One of the smaller apical spines, uropod 2. Norman's specimen	"	265.
8. Third uropod, drawn <i>in situ</i> . Grube's specimen	"	75.
9. Apical margin of telson, a little upturned. Grube's specimen	"	75.

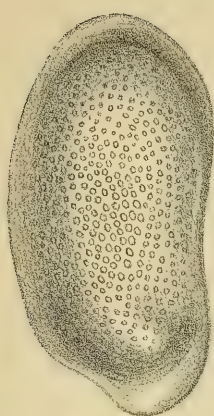
Fig. 10. Hand of first gnathopod, ♂, looking down on the hind margin, from a specimen from Vineyard Sound

11. Finger of second gnathopod, same specimen.	<i>Leptocheirus pinguis.</i>	× 22.
12. Second joint, without the bristles, uropod 3, ♀, Vineyard Sound	" "	× 27.
13. Finger of first gnathopod, small specimen, 4 mm., from Banff	" "	× 75.
14. Tip of finger, second gnathopod, small specimen, 4 mm., from Banff	<i>Leptocheirus hirsutimanus</i>	× 58.
15. Finger of third peraeopod, large specimen, 10 mm., Shetland Isles, 1867	" "	× 145.
16. Outer ramus, third uropod, small specimen, 4 mm., Banff	" "	× 58.
17. Hand and finger, first gnathopod, ♀. Norman's type specimen	<i>Leptocheirus hispidus.</i>	× 50.
18. Finger of second gnathopod, ♀. Norman's type specimen	" "	× 50.
19. Terminal joints, fifth peraeopod, ♀. Norman's type specimen	" "	× 28.
20. Uropod 3, ♀. Norman's type specimen	" "	× 50.

PLATE XIX.

Leptocheirus pectinatus Norman.

Fig 1. Accessory flagellum, superior antenna. Norman's specimen, ♂	× 145.
2. " " " " Chevreux's specimen, large ♂	× 75.
3. " " " " Grube's largest specimen, ♀	× 75.
4. Upper lip	Chevreux's specimen, large ♂. × 75.
5. Lower lip	" " " " × 75.
6. Mandible	" " " " × 75.
7. Maxilla 1	" " " " × 75.
8. Bifurcate spine, outer plate, maxilla 1.	" " " " × 435.
9. Dentate spine, " " " "	" " " " × 435.
10. Maxilla 2	" " " " × 75.
11. Maxillipeds	" " " " × 75.
12. Coupling-spine, inner plate, maxillipeds.	" " " " × 435.
13. First gnathopod (the feathering of the setae on joints 3-6 not shown). Norman's specimen, young ♂, 2.5 mm.	× 95.
14. First sideplate	" " young ♀, 2.75 mm. × 95.
15. First gnathopod. Chevreux's specimen, large ♂, 5.25 mm.	× 40.
16. First sideplate. Grube's specimen, large ♀	× 40.
17. Finger and palm, first gnathopod. Grube's specimen, large ♀	× 95.
(The other setae omitted in order to show the palmar spines clearly.)	
18. Finger and palm, first gnathopod. Chevreux's specimen, large ♂	× 95.
19. Finger of second gnathopod. Norman's specimen, ♂	× 290.
20. " " Chevreux's specimen, ♀	× 145.
21. Sensory spine, 6th joint, peraeopod 4, " " "	× 300.
22. Tip of 4th cleft spine, pleopod 1. " " "	× 300.
23. Third uropod. Norman's specimen, young ♀, 2.75 mm.	× 290.
24. " " Chevreux's specimen, large ♂, 5.25 mm.	× 95.
25. " " Grube's specimen, large ♀	× 75.
26. Uropods and telson. Chevreux's specimen, large ♂, 6 mm.	× 40.
27. Apex of telson. " " "	× 58.
28. " " Grube's specimen, ♀, 5.5 mm.	× 58.



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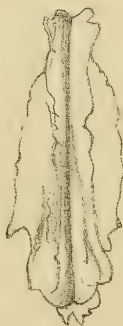
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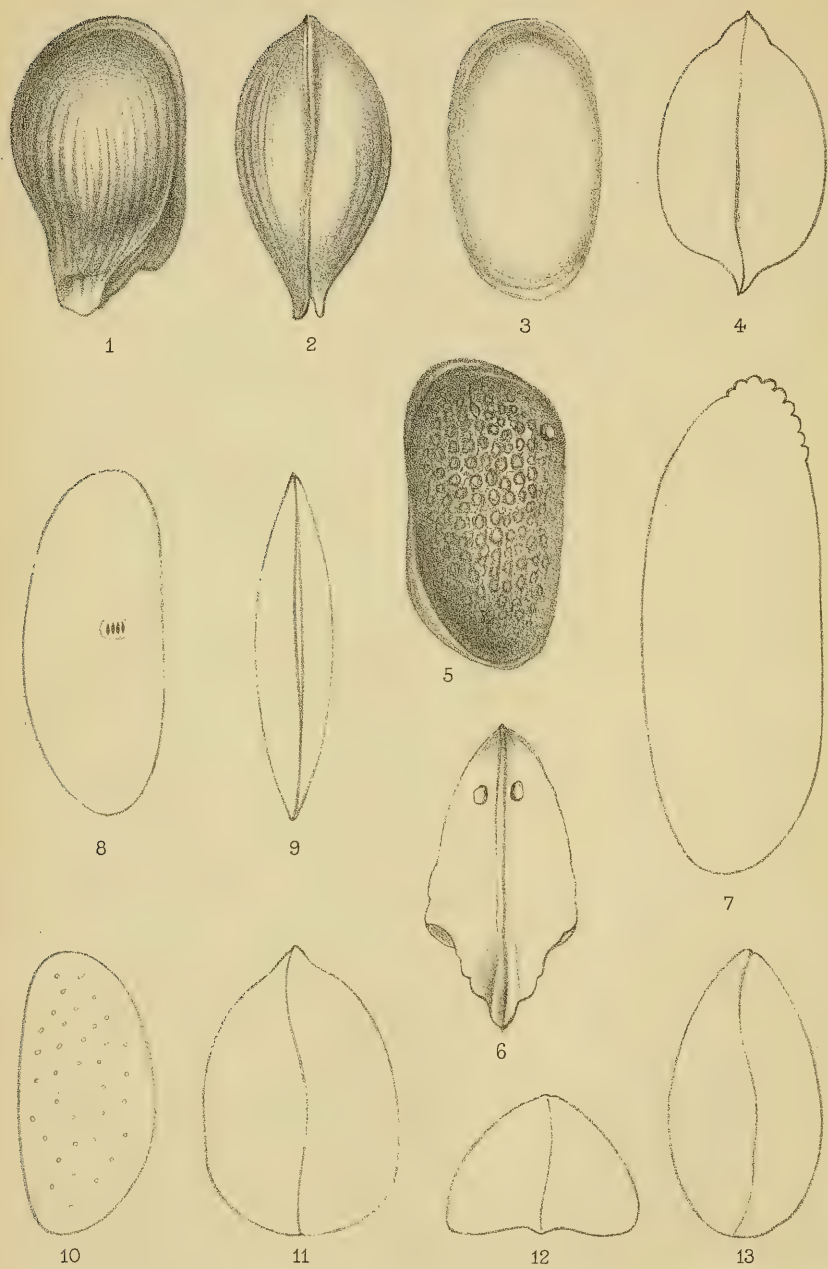


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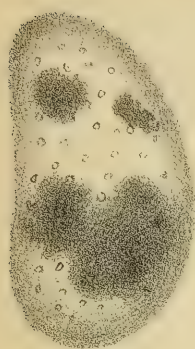


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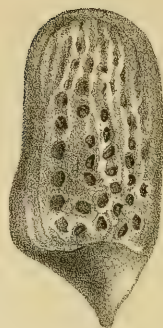
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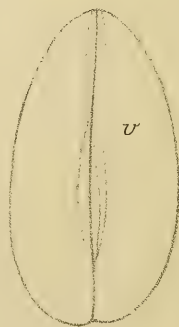
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27. Notes on Marine Ostracoda from Madeira. By G.
STEWARTSON BRADY, M.D., LL.D., D.Sc., F.R.S.,
C.M.Z.S.

[Received January 13, 1911: Read March 21, 1911.]

(Plates XX.-XXII.*)

I am indebted for the specimens which form the subject of the following notes to my friend the Rev. Canon Norman, F.R.S., by whom they were collected in the spring of the year 1897. The mountings submitted to me consisted altogether of dried shells, and in no case was the contained animal preserved, excepting in a few of those collected between tide-marks, and only in some of these littoral forms was the original colouring discernible. Apart from such as appear to be new to science, the collection is interesting as extending the known range of several species from the European and North Atlantic areas much further southward, though not quite into the tropical zone. All the species belong, so far as can be ascertained from the shell-characters, to well-known genera. The following lists show separately the species found in the littoral zone and in deep water.

Between tide-marks.

Cythere convexa Baird.
" *albo-maculata* Baird.
Xestoleberis depressa G. O. Sars.
" *nigromaculata*, sp. n.
" *margaritea* Brady.
Loxoconcha impressa Baird.

Cytherura maculosa, sp. n.
" *cellulosa* Norman.
Sclerochilus laevis? G. W. Müller.
(Pl. XXII. fig. 10.)
Paradoxostoma hibernicum Brady.
" *arcuatum* Brady.

Dredged in 30-70 fathoms.

Bythocypris reniformis Brady.
Macrocypris decora Brady.
Pontocypris succinea G. W. Müller.
" *dispar*? G. W. Müller.
Bairdia amygdaloides Brady.
" *obtusata* G. O. Sars.
" *dubia*, sp. n.
" *mediterranea* G. W. Müller.
" *acanthigera* Brady.

Argillœcia affinis, sp. n.
Cythere crispata Brady.
" *cingulata*, sp. n.
" *tuberculata* G. O. Sars.
" *emaciata* Brady.
Cythereis runcinata Baird.
" *deformis*, sp. n.
" *antiquata* Baird.
" *jonesii* Baird.
Cytheridea elongata Brady.
Eucythere prava Brady & Robertson.

Loxoconcha obesa, sp. n.
" *decipiens* G. W. Müller.
" *impressa* Baird.
" *subalata*, sp. n.
Xestoleberis latissima, sp. n.
Cytherura striata G. O. Sars.
" *cribrosa*, sp. n.
" *cribriformis* G. W. Müller.
" *fossulata*, sp. n.
Cytherideis subulata, var. *crenulata*
Brady.
Sclerochilus contortus Norman.
" *laevis*? G. W. Müller.
(Pl. XXII. fig. 10.)
Paradoxostoma gracile, sp. n.
" *flexuosum* Brady.
" *cylindricum* G. W.
Müller.
Sarsiella capsula Norman.
Cytherella? *ovalis*, sp. n.

* For explanation of the Plates see p. 601.

BAIRDIA DUBIA, sp. n. (Plate XX. figs. 1, 2.)

The outline of the shell as seen laterally is rhomboidal (fig. 1), the greatest height situated near the middle and equal to half the length; anterior extremity obliquely subtruncate, posterior produced below the middle into a wide, obtuse beak; dorsal margin forming a flattened arch, inferior nearly straight, gently sinuated in the middle: seen from above (fig. 2) oblong, ovate, twice as long as broad, greatest width in the middle, sides gently curved, subparallel, extremities produced, the anterior obtusely rounded, posterior prominent and submucronate. Surface of the shell smooth, covered throughout with very small, closely-set, impressed, circular punctations. Colour yellowish grey. Length 0.65 mm.

One specimen only, dredged in 30 fathoms.

ARGILLÆCIA AFFINIS, sp. n. (Plate XX. figs. 9, 10.)

Shell, seen laterally, elongated, siliquose (fig. 9), greatest height in the middle, equal to more than one-third of the length; anterior extremity evenly rounded, narrow, posterior scarcely at all angulated ventrally; dorsal margin forming a continuous even arch throughout, ventral nearly straight through its whole length: seen from above (fig. 10) the outline is narrowly subovate, thrice as long as broad, greatest width in the middle, tapering towards the subacuminate extremities, but more abruptly behind than in front. Surface of the shell perfectly smooth. Colour light grey. Length 0.54 mm.

Several specimens dredged in 70 fathoms.

The differences in form of shell between the various species of *Argillæcia* hitherto described appear to be extremely slight, but that here figured does not seem fairly referable to any one of them.

CYTHERE CRISPATA Brady. (Plate XX. figs. 3, 4.)

Specimens of *C. crispata*, an extreme form of which is here figured, were dredged in 70 fathoms. This form differs from the type in having the extremities—and to some extent the ventral margins—irregularly dentated. This condition, however, is found, though to a much less marked degree, in some of the type-specimens.

These specimens seem indistinguishable from a species described by G. W. Müller—*C. diffusa**; perhaps also from *C. elegans* of the same author.

CYTHERE CINGULATA, sp. n. (Plate XX. figs. 5, 6.)

Shell, seen laterally, oblong, subquadrate (fig. 5), of nearly equal height throughout, height equal to at least half the length; extremities well rounded, the posterior rather the narrower, dorsal margin nearly straight, inclined gently from before backward,

* Die Ostracoden des Golfes von Neapel, p. 354.

ventral slightly sinuated in the middle: seen from above (fig. 6) the outline is oblong, with straight, parallel, lateral margins and strongly produced extremities; the margins converge steeply in front terminating in a stout median process, behind they converge almost rectangularly and form a very wide central hump. Surface of the shell covered with rounded and closely-set impressed pittings, and bordered in front and behind with a smooth depressed fillet. Length 0.78 mm.

One specimen dredged in 30 fathoms, and one in 70 fathoms.

CYTHEREIS DEFORMIS, sp. n. (Plate XX. figs. 7, 8.)

Shell, seen laterally, oblong, subquadrate, greatest height situated near the front and equal to nearly half the length (fig. 7); anterior extremity well rounded and bordered with a series of short, blunt teeth; posterior extremity much narrower, truncated, prominently angular in the middle and divided below the middle into a few irregularly tooth-like processes; dorsal margin sloping gradually from the front backwards, ventral margin almost straight: seen from above (fig. 8) the outline is compressed, oblong, about thrice as long as broad, the lateral margins very irregular, with a sharply prominent angle at the posterior third; extremities much produced, broadly truncate, with irregularly dentate margins. Shell-surface irregularly rugose, with a wide depressed band stretching round and within the anterior margin; a sharply elevated crest running obliquely across the posterior half and terminating in a sharply produced angle on its dorsal aspect. Length 0.5 mm.

Dredged in 70 fathoms.

It is impossible, by the shell-characters alone, to separate clearly the species belonging to the two genera *Cythere* and *Cythereis* as they are now understood by most authors, nor, as it appears to me, are the distinctive characters of the contained animal much more satisfactory.

LOXOCONCHA OBESA, sp. n. (Plate XXI. figs. 3, 4.)

Shell, seen laterally, elliptical, greatest height situated in the middle and equal to half the length (fig. 3); extremities evenly rounded, the posterior somewhat the narrower of the two; dorsal margin very slightly arcuate, ventral almost straight, not at all sinuated: seen from above (fig. 4) the outline is very broadly oval with strongly produced mucronate extremities, width considerably exceeding half the length, lateral margins very strongly convex. Shell-surface perfectly smooth. Colour grey. Length 0.46 mm.

Dredged in 70 fathoms; one specimen only.

LOXOCONCHA DECIPIENS G. W. Müller. (Plate XXI. figs. 1, 2.)

Several specimens, agreeing very accurately with the figures given by Dr. G. W. Müller, were dredged in 70 fathoms. One quite characteristic specimen is figured here.

LOXOCONCHA SUBALATA, sp. n. (Plate XXI. figs. 5, 6.)

Shell, seen from the side, oblong, subrhomboidal, twice as long as broad (fig. 5); anterior extremity obliquely rounded, posterior very obliquely rounded below the middle; ventral margin rather deeply sinuated in the middle, curving suddenly upwards behind, dorsal margin perfectly straight: seen from above (fig. 6) hastate in outline, prominently angulated behind the middle, from which point the sides converge with a gentle curve to the anterior extremity, which is sharply acuminate; behind the two lateral angles the margins converge rather sharply in an irregularly sinuous curve to the posterior extremity: the general contour is thus made of two wedge-shaped portions—an anterior larger wedge and a posterior small one. Shell-surface rough, marked by closely-set small fossæ, sharply elevated in the postero-ventral regions, beneath which it is depressed, forming a somewhat flattened curved lip. Length 0·38 mm.

Dredged in 70 fathoms.

XESTOLEBERIS LATISSIMA, sp. n. (Plate XXI. figs. 10–13.)

Shell, seen laterally, oblong, subovate, quite twice as long as broad (fig. 10), highest behind the middle; anterior extremity narrowly rounded, posterior sloping with a steep curve to the ventral margin, where it forms a rounded angle; dorsal margin forming a somewhat flattened arch, sloping steeply behind, more gently in front, ventral margin nearly straight: seen from above (fig. 11) the outline is excessively tumid, ovate, widest behind the middle, width equal to two-thirds of the length, mucronate in front, broadly rounded behind; the end view (fig. 12) is very broadly wedge-shaped, widest ventrally where the angles are moderately rounded off, height equal to about two-thirds of the width. Shell-surface perfectly smooth, marked in some cases with a very few small papilliform tubercles. Colour white. Length 0·75 mm.

Dredged in 70 fathoms.

The outline shown in fig. 13 may perhaps be referable to the male, the more tumid outline to the female.

XESTOLEBERIS NIGROMACULATA, sp. n. (Plate XXII. figs. 1–3.)

Shell of the female, seen laterally, oblong, subreniform, greatest height situated in the middle and equal to half the length (fig. 1); anterior extremity depressed, rounded, posterior much wider and evenly rounded; dorsal margin boldly arched, ventral sinuated in the middle: seen from above (fig. 2) ovate, gradually tapering to the anterior extremity, which is rather sharply pointed, much broader and well rounded behind, width and height equal. Surface of the shell smooth, yellowish in colour, with irregular clouded dark patches, and bearing a few very minute distinctly scattered circular papillæ. Eye-spots very conspicuous. Length 0·55 mm.

Shell of the male (fig. 3) rather smaller, more markedly depressed in front and more elevated dorsally.

Several specimens taken between tide-marks.

CYTHERURA MACULOSA, sp. n. (Plate XXII. figs. 6, 7.)

Shell, seen laterally, oblong, subreniform, highest in the middle (fig. 6), height equal to half the length; anterior extremity evenly rounded, posterior produced in the middle into a wide obtusely pointed beak; dorsal margin evenly arched throughout, ventral rather deeply sinuated in the middle, prominent behind, thence sloping with a sinuous curve up to the beak: seen from above (fig. 7) oblong, three times as long as broad, lateral margins parallel throughout the greater part of their length, converging towards the front; anterior extremity broad and truncated, posterior produced into a wide median beak. Surface of the valves marked with faint longitudinal striæ and with minute, closely-set, impressed pits; in most cases the middle of the valve bears a dark transverse blotch of irregular shape, but this may be absent or much reduced in size. Length 0.39 mm.

Several specimens from low-water mark.

CYTHERURA CRIBROSA, sp. n. (Plate XXII. figs. 4, 5.)

Shell, seen from side, oblong, rhomboidal, height scarcely equal to half the length; anterior extremity well rounded, posterior produced above the middle into a very large and rather sharp beak (fig. 4); dorsal margin straight throughout almost its whole length, ventral rather deeply sinuated in the middle, behind which it bulges ventrally: seen from above, oblong, subovate, width scarcely equalling half the length (fig. 5), rather abruptly tapered and subacuminate in front, posteriorly abruptly truncated and produced into a large central beak. Surface of the shell honeycombed with large subrotund fossæ, which are arranged in irregular longitudinal rows. Length 0.44 mm.

Many specimens dredged in 50 fathoms.

CYTHERURA FOSSULATA, sp. n. (Plate XXII. figs. 8, 9.)

Shell, seen laterally, oblong, rhomboidal, of nearly equal height throughout, length equal to more than twice the height (fig. 8); anterior extremity obliquely subtruncate, often indented below the middle, the sinuations bounded by two small nodules, two rounded tubercles near the anterior extremity, just within the superior margin, over the region of the eyes; posterior extremity oblique, produced above the middle into a large upward-pointing beak; dorsal margin perfectly straight, ventral nearly straight, with a slight ventral convexity: seen from below (fig. 9) the outline is that of an arrowhead, the lateral acute prominences situated near the posterior third, the width at that point equal to more than half the length of the shell, behind these angles the shell is suddenly narrowed, forming a rounded hinder end which terminates in a large median beak: anteriorly the lateral margins converge with a deep curvature to the front, ending in a wide bluntly rounded extremity. The surface of the shell is variously and very irregularly marked with furrowed undulations more or less transverse in their direction, and by a conspicuous curved longitudinal crest which ends behind the middle near the ventral

margin in a sharply angular projection: in some cases there is a distinct longitudinal striation, more especially on the ventral surface, and posteriorly near the base of the beak may be seen a series of four nodules, the terminations of small curved carinae (fig. 9). Length 0.46 mm.

Several specimens were dredged in depths of 50-70 fathoms.

The surface-ornament of this species varies very much: the foregoing description should be taken as belonging to a rather strongly marked specimen. The variations of sculpture seem to depend chiefly on conditions of age and sex.

CYTHERIDEIS SUBULATA, var. *CRENULATA*, nom. n. (Plate XXI. fig. 7.)

Specimens, of which a figure is here given, seem to be identical with a form described in 1874 by myself and the late Dr. Robertson under the name *Cytherideis subulata* var. *fasciata*, the varietal designation having been used on account of the presence of a dark band across the shell. But the type specimens, taken among the Scilly Islands and now in my collection, do not now exhibit any such marking. It is possible that the markings may have disappeared with exposure to the air, and as the published name is inappropriate, I propose to substitute the varietal term *crenulata*. In the Madeira specimens, which were taken in a depth of 70 fathoms, the anterior crenulations are much more developed than in those from Scilly, but in all other respects those from the two localities are alike.

PARADOXOSTOMA GRACILE, sp. n. (Plate XXI. figs. 8, 9.)

Shell, seen laterally, oblong, subclavate, height equal to more than one-third of the length; extremities rounded off, the anterior narrower and somewhat depressed (fig. 8), dorsal margin evenly but not very strongly arcuate, ventral almost straight: seen from above (fig. 9) extremely compressed, widest in the middle and tapering evenly to the extremities, which are very acutely pointed, width equal to about one-fourth of the length. Shell-surface perfectly smooth and colourless. Length 0.55 mm.

One specimen only, taken in 70 fathoms.

CYTHERELLA (?) *OVALIS*, sp. n. (Plate XXII. figs. 11, 12.)

Shell, seen laterally, subelliptical, about twice as long as broad (fig. 11); anterior extremity rounded above and below, almost subtruncate, posterior narrower and somewhat oblique, dorsal margin almost straight, ventral straight, upcurved toward the posterior extremity: seen dorsally the outline is ovate (fig. 12), twice as long as broad, greatest width behind the middle; extremities well rounded, the anterior much narrower than the posterior. Shell-surface perfectly smooth. Colour white. Length 0.42 mm.

Dredged in 70 fathoms.



1



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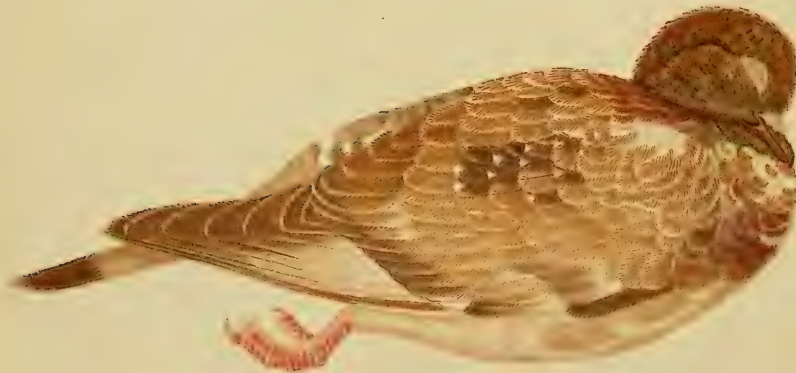
West, Newman chr.



1



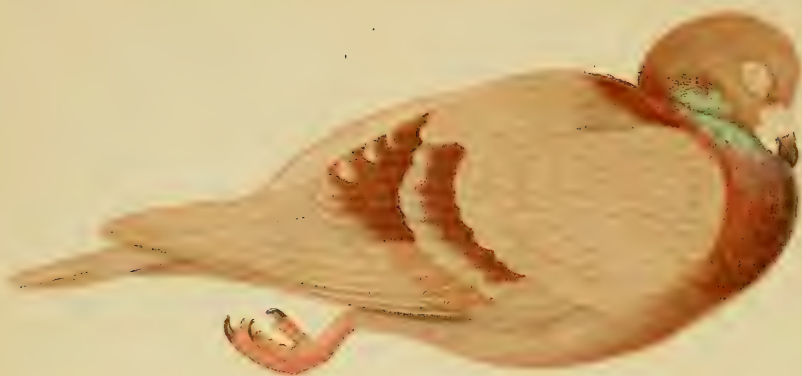
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3

West, Newman chr.

1. DARK GRIZZLE. 2. WHITE GRIZZLE.
3. GRIZZLED CHEQUER.



1



2



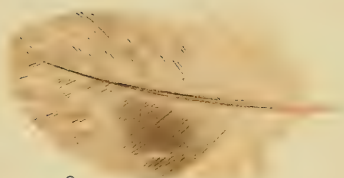
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West, Newman chr.

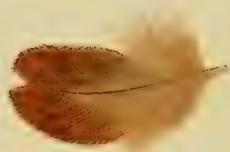
1. DARK MEALY. 2. LIGHT MEALY.
3. WHITE MEALY.



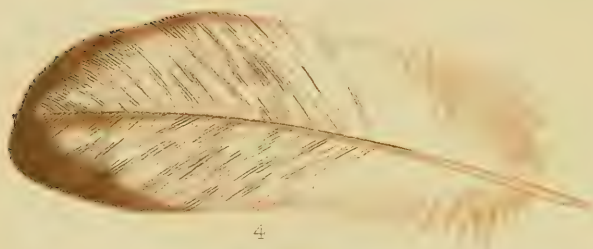
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4



5



6

West, Newman chr.

FEATHERS SHOWING PATTERN MARKINGS.

EXPLANATION OF THE PLATES.

PLATE XX.

- Figs. 1, 2. *Bairdia dubia*. × 84.
 3, 4. *Cythere crispata*. × 110.
 5, 6. " *cingulata*. × 110.
 7, 8. *Cythereis deformis*. × 84.
 9, 10. *Argillæcia affinis*. × 84.

PLATE XXI.

- Figs. 1, 2. *Loxoconcha decipiens*. × 90.
 3, 4. " *obesa*. × 84.
 5, 6. " *subalata*. × 115.
 Fig. 7. *Cytherideis subulata*, var. *crenulata*. × 84.
 Figs. 8, 9. *Paradoxostoma gracile*. × 84.
 10-13. *Xestoleberis latissima*. × 110.

PLATE XXII.

- Figs. 1-3. *Xestoleberis nigromaculata*, ♀ ♂. × 84.
 4, 5. *Cytherura cribrosa*. × 100.
 6, 7. " *maculosa*. × 100.
 8, 9. " *fossulata*. × 100.
 Fig. 10. *Sclerochilus lævis*? × 84.
 Figs. 11, 12. *Cytherella ovalis*. × 100.

28. On Colour and Colour-pattern Inheritance in Pigeons.
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 SMALLEY, F.Z.S.

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(Plates XXIII.-XXVI.*)

The following is a preliminary account of some experiments undertaken by the authors to throw some light on the inheritance of colour and colour-pattern in Pigeons. These experiments are being continued, as the matter is a long and complicated one and will of necessity take several years to complete.

The experiments on certain colours and colour-patterns, however, have been practically completed, and the results are briefly given below.

Apart from the practical knowledge given in books on fancy pigeons, no serious work has been published on the inheritance of colour in Pigeons except Darwin's (*Animals and Plants under Domestication*, vol. i. p. 197 *et seq.*, 1868 ed.), and a recent paper by Mr. Staples-Browne (*P. Z. S.* 1908, p. 67).

The information in the 'fancy' books, valuable as a guidance for practical breeding, is of little utility from the scientific point of view, as details of pedigrees are often lacking. The work of Darwin we have also had to pass over, for the present, owing to the difficulty of making out with any accuracy the exact colour of his birds from the terms he used. It is by no means intended to imply inaccuracy in that most accurate of observers, but the 'fancy' terms for colours, though well understood by breeders, do

* For explanation of the Plates see p. 619.

not readily admit of a scientific interpretation unless the birds themselves can be seen; frequently the same colour (from a scientific point of view) may be known by different names according to the particular breed of pigeons that may be under discussion.

Darwin's experiments related chiefly to "reversion," *i.e.* the re-appearance of the blue colour when distantly related breeds of pigeons were crossed, and although our work has not been on the same lines, the study of the blue colour should, none the less, bear out the results arrived at years ago. We are not unmindful of this, and for that very purpose hope to mate up several pairs to test Darwin's conclusions.

Lastly there is Mr. Staples-Browne's recent paper, in which he has attempted to repeat Darwin's experiments. This paper we have been through very carefully, and find that in the main it agrees with our results, but one or two little difficulties have to be met, such as the occurrence of a Dun in Exp. 27, the absence of Blacks in Exps. 9 & 11, the large proportions of white in Exps. 16-23 and 30, and the occurrence of white feathers on a homozygous blue.

We have no doubt that further work will clear up these slight difficulties, which do not, however, greatly affect the main result; in fact a possible explanation of some of them has already suggested itself to us, but the discussion of these is best deferred until the results of our matings on the same lines as Darwin and Staples-Browne have been obtained.

The majority of the birds used have been highly bred Dragoons, but in a very few cases a Homer cross has been introduced.

The characters dealt with in this paper are:—

- (i) Colour-patterns, *i.e.* Chequering, Grizzle, and Mealy.
- (ii) Colours, *i.e.* Blue and Silver, with White and Red in those cases where it is connected with Grizzle and Mealy.

Before detailing the experiments, however, it is necessary to have a clear understanding of the terms used.

- (i) *Chequering*. This is a pattern chiefly confined to the wing-coverts, in which each chequered feather has a light coloured V-shaped patch at its distal end, the apex of the V being nearest the base of the feather (see Pl. XXVI. fig. 1). The general appearance of a good chequered bird is shown in Pl. XXIII. fig. 3, but it must be understood that scientifically and in the experiments we have carried out, a bird has been considered as chequered when it showed the characteristic markings on its wings.
- (ii) *Grizzling*. A grizzled feather is one in which the barbs are partially white and partially coloured. This pattern is not restricted to any particular part of a bird, but grizzled feathers may be found in any feather tract including the remiges and rectrices.

On a grizzled bird (*i.e.* a bird with grizzled feathers) whole coloured feathers are generally found as well as feathers splashed with white (Pl. XXIV. figs. 1 & 2;

Pl. XXVI. figs. 2 & 4). The term 'Grizzle' is restricted in the 'fancy' to birds whose pigment is Blue grizzled with White.

- (iii) *Mealy*. From the pattern point of view a Mealy is identical with a Grizzle but the White coloration is to a greater or lesser extent replaced by Red. A Mealy (for Mealy feathers see Pl. XXVI. figs. 5 & 6; the birds are figured on Pl. XXV.) may therefore show *Blue* and *Red*, or *Blue*, *Red* and *White*.
- (iv) *Blue* (Pl. XXIII. fig. 1) is the colour of the Wild Rock Pigeon, although in domestic breeds the rump is not necessarily white. In a Blue Chequer (Pl. XXIII. fig. 3) the light apical portions of the feathers are of the typical blue colour, the rest of the feather and the general appearance of the bird being very much darker. A very dark Blue Chequer is almost black, but this black is usually dull and must not be confused with the glossy black (beetle-black) characteristic of a pure black pigeon.
- (v) *Silver* is a *very* pale blue with black bars and "dun" flights. In a Blue pigeon the flights are black (Pl. XXIII. fig. 2).
- (vi) *Red*. A Red pigeon is deep red all over including the flights and tail. In a Red Chequer the dark portion of the feathers are of the normal red and the light apical spots white. The flights and tail are white.

It must be remembered that all these varieties show considerable differences in shades of colour, and in the intensity and abundance of the pattern markings. In this paper, however, we do not propose to enter into these details, important as they are. Our object for the present is to separate those characters which follow apparently a Mendelian inheritance, from those whose mode of inheritance is different. This paper therefore will only deal with Mendelian inheritance, except to note in a few cases where that inheritance is apparently subservient to other causes. None the less these differences of shade and amount of pattern do obviously follow a definite law of inheritance, and they are by no means being disregarded by us, nor are we without hope of being able at some future time to attempt some explanation of the laws which govern their inheritance.

We may point out further that in the case of Mealties and Grizzles (*i.e.* where *normally* there should be a small amount of white), there is a great tendency to breed out in the course of a few generations to practically pure white with only a few coloured feathers. Our results, as far as they have gone, seem to show, however, that these nearly pure white birds are still transmitting to their offspring the colour which characterised their parents and grandparents.

Blues and Silvers.

Blue is dominant to Silver.

A careful analysis of our results shows that Silver is in reality a dilute Blue and that the colour factor in both is identical. The

allelomorph is therefore concentration and dilution (c and d) of which the former is dominant.

Blue may therefore be represented as BBcc or BBcd, where B represents the blue colour factor. Silver must therefore be represented by BBdd.

Blues are said to almost always breed true, that is to say, that they never throw any Silvers—this idea owes its origin, however, to the fact that those Blues which are impure dominants (*i.e.* containing the factor d) are of a poorer colour than the pure Blues and have in consequence long been rejected by fanciers, so that a race of pure dominants has thus been evolved*. Several of our matings show that Blues or Grizzles that are heterozygous as regards c and d will throw Silvers†.

The following are the results of our matings for these particular characters, with the exception of Experiment 83, which is introduced to show the reappearance of Silver from two heterozygous Blues.

Exp. [‡] No.	♀	Ext. App.	Gametic Formula.	From Exp.	♂	Ext. App.	Gametic Formula.	From Exp.	Expectation.	Result.
83.	00/61	Grizzle	<i>BBcdGg</i>	—	02/126	Blue	BBcdgg	—	3 B 1 S.	6 B 2 S
148.	04/70	Silver	<i>BBdd</i>	—	04/21	Silver	BBdd	—	All S	— 5 S
149.	05/96	"	<i>BBdd</i>	—	05/51	"	BBdd	—	"	— 3 S
150.	07/4	"	<i>BBdd</i>	—	06/56	"	BBdd	—	"	— 5 S
151.	05/96	"	<i>BBdd</i>	—	05/21	"	BBdd	—	"	— 1 S
152.	03/5	"	BBddgg	83	04/140	Grizzle	<i>BBcc or cā</i>	157	All B or Equality	1 B 1 S
153.	04/10	"	BBdd	140	{ 04/10 revd. }	"	<i>BBcc or cd</i>	77	" "	7 B —
154.	04/14	Grizzle	<i>BBcc or cd</i>	96	07/52	Silver	BBdd	151	" "	4 B 2 S
155.	08/1336	Silver	BBdd	148	08/1363	Grizzle	<i>BBcc or cd</i>	137	" "	6 B —
156.	03/5	"	BBdd	83	01/50	Blue	<i>BBcc</i>	—	All Blue	3 B —
157.	03/6	"	BBdd	83	02/31	"	<i>BBcc</i>	—	" "	4 B —
158.	05/95	Blue	<i>BBcc or cd</i>	105	05/51	Silver	<i>BBdd</i>	—	" "	2 B —
159.	06/13	"	<i>BBcd</i>	65	06/66	"	BBdd	—	Equality	1 B 1 S
160.	03/5	Silver	BBdd	83	02/126	Blue	BBcd	—	"	3 B —
161.	07/4	"	BBdd	—	06/67	"	BBcd	158	"	3 B —
162.	04/52	Blue	BBcd	156	06/56	Silver	BBdd	—	"	2 B 2 S
163.	08/1335	Silver	BBdd	148	08/1387	Blue	BBcd	154	"	3 B 3 S

When the Gametic Formula is in italics it implies that it is not *definitely* known. Only the characters under immediate consideration are given in the Gametic Formula.

* See also remarks on chequering.

† We must, however, point out here that in Mr. Staples-Browne's experiments, one or two blues, apparently heterozygous, behaved as homozygous and *vice versa*.

‡ With regard to the numbering of Experiments—the numbers refer to our study book, and rather than number the experiments quoted successively in this paper, it was thought best to have only one set of numbers so that references might at any future time be easily made without risk of confusion.

From these matings we see that :—

- (i) Silver to Silver (Exps. 148 to 151) gives nothing but Silver, according to expectation.
- (ii) Blue to Silver (Exps. 152 to 159) should give nothing but Blues or Blues and Silvers according to whether the Blues are heterozygous or not, and we see that when our knowledge of the gametic formulæ of the parents was known for certain, the results were in exact accord with expectations, and no results antagonistic to possible expectations occurred.
- (iii) Heterozygous Blues to Silvers (Exps. 160–163) should give equality of Blues and Silvers. In the case of Exps. 160 and 161 no Silvers appeared, but the numbers bred were very small. In the other experiments, exact equality was reached, so that we may well assume that a continuation of the other experiments would have led to the appearance of some Silvers.
- (iv) Heterozygous Blue \times Heterozygous Blue should give Blues and Silvers in proportion of 3:1, which was the exact result of this mating (Exp. 83).

The results therefore show clearly that Silver is recessive to Blue. The arguments showing that the difference between these colours is one of concentration and dilution (rather than a difference of the colour factor itself), depend on the study of this dilution factor, which, as it concerns the inheritance of other colours and shades, not dealt with in this paper and at present only imperfectly understood, is best deferred for the present. Its discussion in no way affects the proof of the dominance of Blue over Silver.

Chequering.

Chequering is dominant to pure colour. It is difficult to realize therefore how it can have originated, since the *typical* wild pigeon shows no such markings. At the present time, however, in many parts of the country wild birds show chequering, but it seems more than likely that in these cases the marking has been introduced by a cross with the domestic bird, as most of the Wild Rocks in this country are now intermixed with feral ones. Once this cross had been effected the chequering would of course frequently show itself.

In direct contradiction to the foregoing remarks the following fact is worth noting. Some years ago a pair of pure wild birds was taken by one of the authors from a remote district in the West of Ireland. All the wild pigeons seen (and there were no tame ones within a radius of at least 30 miles) were purely typical Blue Rocks. This pair bred in an aviary for five or six seasons, producing only typical wild birds like themselves. Two seasons ago (in 1909) an attempt was made to establish some of their progeny as semi-wild birds and they were allowed to fly at liberty from a dove-cot. One pair remained and reared several young, one of which proved to be chequered!

Scientifically this result is of but little value, as the hen bird *may* have made a chance mating with a chequered pigeon; on the other hand, the youngster was in every other respect (shape and size) a typically wild bird. Unfortunately it met with an accident, so that we have not been able to breed from it.

Unsatisfactory as this case is, it is obvious that the chequering must in the first place have originated from the Wild Rock Pigeon, and the above is probably a good example of its arising as a mutation.

A further explanation may possibly be found in the fact that the chequering cannot show itself except in the presence of two shades of colour, and that it may be present in many of the pure wild birds but cannot show itself until the colour factor producing the two shades is present, when the chequering will immediately appear.

This, however, in no way affects the main issue, namely that when once a Chequer has been produced it is dominant to the pure colour. The mating of two Chequers should therefore produce Chequers or Chequers and Self-colour, according to whether the birds are homozygous or heterozygous for that character.

As in the case of the Blues, so in the case of the Chequers it appears that fanciers, by continually selecting the best birds for breeding, have unconsciously been selecting only homozygous birds, with the result that only pure Chequer dominants are to be found in certain strains. We have for instance accurate records of 57 matings (Exps. 1-49; 169-172; 175-178) of Chequer to Chequer from which 229 young were produced, and all these without exception were Chequers like their parents. It therefore became essential to carry out further matings with birds that were known to be heterozygous in order to test the dominance of the Chequer character. This has been done in the matings detailed below, the results of which, as will be seen, approximate very closely to the Mendelian expectation.

Exp. No.	♀	Ext. App.	Gametic Formula.	From Exp.	♂	Ext. App.	Gametic Formula.	From Exp.	Expectation.	Result.
174.	06/104	{ Red Chequer. }	Xx	173	06/82	Blue.	xx	122	Equality	2 Ch : 2 B
196.	650	{ Blue Chequer. }	Xx	14 S-B	06/69	Grizzle.	xx	153	„	3 : 2
197.	07/b	{ Grizzle Chequer. }	Xx	196	08/c	Blue.	xx	196	„	5 : 3
198.	07/a	{ Grizzle Chequer. }	Xx	196	08/d	Blue Chequer.	Xx	196	3 : 1	2 : 2
199.	07/b	{ Grizzle Chequer. }	Xx	196	08/13	Grizzle.	xx	196	Equality	2 : 0
200.	03/19	{ Blue Chequer. }	Xx	197	08/22	Blue Chequer.	Xx	197	3 : 1	10 : 1 *
201.	09, 533	{ Blue Chequer. }	Xx	197	08/36	Blue Chequer.	Xx	198	3 : 1	3 : 3 *
203.	08/24	{ Grizzle Chequer. }	Xx	198	08/30	Grizzle.	xx	197	Equality	7 : 2

Chequering and its absence are represented by X and x.

* Matings for the purpose of testing the extracted recessives from Exps. 200 and 201 have been undertaken this year (1911), and prove the recessives to breed true.

It should perhaps be noted that although the individual matings show, considering the small numbers, a very close approximation to the expected results, yet at the same time the tendency to vary from the anticipated results is all in one direction, viz. to a greater number of Chequered birds. This is most marked in those matings where equality was expected, for of the 28 birds bred, 19 were Chequers; in those cases where the expectation was 3 : 1, 21 birds were bred of which 15 were Chequers, which is approximately correct. It is possibly due as much to this tendency as to the unconscious selection by breeders, that this character has become perfectly true and stable in some strains. As pointed out in the earlier portion of this paper, we are restricting our remarks for the present to the consideration of the Mendelian inheritance of certain characters, and that theory seems to fit in well with the main lines of inheritance as borne out by the facts. None the less it is equally evident that there are other factors at work, which are able to modify to some extent the results anticipated by the Mendelian hypothesis. In addition to these definite matings we have also notes of 6 matings Chequer to pure colour (Exps. 164-168, 173) which gave 19 birds all chequered. In this latter set of matings most of the Chequered parents were birds used in or bred from the Chequer to Chequer matings; and therefore this adds further proof that all those birds were homozygous dominants, as otherwise we should have expected some self-coloured birds to appear as they did in Exps. 174-203 (p. 606).

It may be as well to mention here that although some of the matings referred to in this paper were not undertaken with the special purpose of bringing out the facts which they are used to interpret, yet they have all been conducted by one of the authors in person. Special matings have, however, been made in every case to prove the inheritance of the characters discussed*.

Grizzling.

Grizzling is dominant to Chequering and hence also to pure colour. It probably originated from the cross between Blue and White, although such matings usually give splashed birds, owing probably to the true Grizzle character, in which individual barbs show both white and blue, being absent. Cases, however, are known in which the cross between pure White and pure Blue have produced Grizzles, and in these cases there is little doubt that the Grizzle character must have been present in one or both of the parents but was unable to show itself owing to the bird containing only one colour. Once, however, the Grizzle has shown itself, the White and Grizzle characters seem to combine together and to have a common inheritance. Furthermore, as already stated, Grizzles when bred together tend usually, but not invariably, to show an increase of white in successive generations

* Mr. W. Bateson has stated (Mendel's Principles of Heredity, p. 43 (1909)) that chequering is dominant to its absence; on writing to him for a reference to the source of his statement, he says that he had in mind some experiments of Mr. Staples-Browne, which have, however, not been published.

till eventually some birds will be produced showing only one or two coloured feathers. This matter, however, we shall not discuss at present.

For our present purpose we may ignore the White character, assuming that it is always present and inherited in common with the Grizzle. The gametic formula, therefore, of a grizzled bird will be BBcc or cd GG or Gg, where B is the Blue colour, c & d concentration or dilution (the combination dd producing a bird known as a Silver Grizzle), and G & g the presence or absence of Grizzle. Therefore from the crossing of two Grizzles we may either get all Grizzles or Blues and Grizzles, according to whether the birds are homozygous or heterozygous to the Grizzle character. Under the term Blue we here for simplicity's sake include Silver.

Again, as in the case of the Chequers, the results from pedigrees are apt to be misleading owing to the difficulty of distinguishing the homozygous from the heterozygous birds; nevertheless such results entirely bear out our hypothesis, since, as regards the colours produced, the results are quite in accordance with expectations.

Grizzle to Grizzle.*

Exp. No.	♀	Ext. App.	Gametic Formula.	From Exp.	♂	Ext. App.	Gametic Formula.	From Exp.	Expectation.	Result.
74.	02/46 [L]	Grizzle	GG or Gg	—	99/104	Grizzle	GG	—	All G or 3:1	3 Grizzles
75.	03/21	"	Gg	87	93/88	"	GG or Gg	—	" "	5 Grizzles
76.	00/21	"	GG or Gg	—	63/7	"	GG or Gg	—	" "	4 Grizzles
77.	00/61	"	Gg	—	99/104	"	GG	—	" "	7 Grizzles
78.	04/21	"	GG or Gg	76	04/58	"	Gg	94	" "	4 G 2 B
79.	04/23	"	Gg	99	06/102	"	Gg	153	3:1	4 G 1 S
80.	04/1 rev.	"	Gg	99	05/6	"	Gg	109	3:1	1 G' —
81.	04/12	"	Gg	103	01/15	"	GG or Gg	—	All G or 3:1	1 G 1 B
82.	06/88	"	GG or Gg	78	04/58	"	Gg	94	All G or 3:1	— 1 B

* As before, only the character dealt with is shown in the Gametic Formula.

Looking through these matings, we see that when both Grizzles and Blues should have appeared the expected proportion ought to have been 3:1, and the results give 10:5 or a rather large excess of Blues.

Grizzle to Blue.

These matings (Exps. 83-138, 152-155) may be divided into two groups: (1) those in which the gametic formulae of both parents were known; (2) those in which, owing to the gametic formula of one parent being doubtful, two expectations were possible.

Certain of the Grizzles were known to be heterozygous: this was the case in 19 matings, in which therefore Grizzles and Blues should have appeared in approximately equal numbers. Altogether 64 young were reared, 37 Grizzles and 27 Blues, thus showing a slight excess of Grizzles.

Grizzle to Blue.

Exp. No.	♀	Ext. App.	Gametic Formula.	From Exp.	♂	Ext. App.	Gametic Formula.	From Exp.	Expectation.	Result.
83.	00/61	Grizzle	GG or Gg	—	02/126	Blue	gg	—	All Gg or Equality	4 G 4 B
84.	01/27	Blue	gg	—	01/28	Grizzle	GG or Gg	—	" "	5 G 1 B
85.	01/10	"	gg	—	08/26	"	GG or Gg	—	" "	1 G —
86.	00/21	Grizzle	GG or Gg	—	02/35	Blue	gg	—	" "	1 G 2 B
87.	00/6 rev.	Blue	gg	—	02/24	Grizzle	GG or Gg	—	" "	2 G 4 B
88.	02/9	"	gg	—	01/24	"	GG or Gg	—	" "	2 G 4 B
89.	02/37	Grizzle	GG or Gg	—	02/41	Blue	gg	—	" "	1 G 2 B
90.	02/46 (a)	"	GG or Gg	—	21	"	gg	—	" "	4 G —
91.	02/46 (b)	"	GG or Gg	—	43	"	gg	—	" "	— 6 B
92.	03/31	Blue	gg	84	02/23	Grizzle	GG or Gg	—	" "	— 5 B
93.	01/27	"	gg	—	01/15	"	"	—	" "	4 G 2 B
94.	03/19	"	gg	86	01/24	"	"	—	" "	2 G 2 B
95.	03/11	"	gg	51	02/77	"	"	—	" "	4 G 1 B
96.	01/13	"	gg	—	01/28	"	"	—	" "	4 G 1 B
97.	03/37	Grizzle	GG or Gg	—	02/38	Blue	gg	—	" "	— 3 B
98.	03/20	"	Gg	—	02/22	"	gg	—	Equality	1 G 2 B
99.	01/11	Blue	gg	—	03/9	Grizzle	Gg	84	" "	5 G 1 B
100.	01/10	"	gg	—	00/53	"	GG or Gg	—	All Gg or Equality	— 1 B
101.	02/19	"	gg	—	98/96	"	"	—	" "	3 G 3 B
102.	02/34	Grizzle	GG or Gg	—	02/26	Blue	gg	—	" "	— 1 B
103.	98/9	"	gg	—	02/20	"	gg	—	" "	1 G 3 B
104.	00/6	Blue	gg	—	03/53	Grizzle	Gg	88	Equality	1 G —
105.	02/52	"	gg	—	03/7	"	GG or Gg	—	All Gg or Equality	2 G 4 B
106.	01/27	"	gg	—	01/24	"	GG or Gg	—	" "	— 1 B
107.	02/46 (b)	Grizzle	GG or Gg	—	02/25	Blue	gg	—	" "	1 G 5 B
108.	03/75	"	"	74	03/51	"	gg	53	" "	3 G 2 B
109.	02/46 (a)	"	"	—	03/23	"	gg	53	" "	2 G 5 B
110.	01/31	Blue	gg	59	03/9	Grizzle	Gg	84	Equality	2 G 1 B
111.	01/7	"	gg	95	00/53	"	GG or Gg	—	All Gg or Equality	1 G 3 B
112.	01/4	"	gg	—	01/28	"	GG or Gg	—	" "	2 G 2 B
113.	03/29	"	gg	88	02/77	"	GG or Gg	—	" "	3 G 3 B
114.	00/21	Grizzle	GG or Gg	—	04/84	Blue	gg	157	" "	2 G 3 B
115.	01/3 rev.	Blue	gg	61	03/8	Grizzle	GG or Gg	—	" "	1 G 1 B
116.	00/61	Grizzle	Gg	—	01/12	Blue	gg	61	" "	6 G —
117.	05/14	Blue	gg	65	01/53	Grizzle	GG or Gg	—	" "	3 G 5 B
118.	01/121	"	gg	59	01/24	"	"	—	" "	1 G —
119.	01/7	Grizzle	GG or Gg	—	02/22	Blue	gg	—	" "	2 G 3 B
120.	02/46 (a)	"	"	—	04/53	"	gg	61	" "	2 G —
121.	03/75	"	"	74	01/48	"	gg	—	" "	2 G 4 B
122.	02/46 (b)	"	"	—	03/78	"	gg	53	" "	1 G 5 B
123.	01/4 rev.	Blue	gg	61	05/6	Grizzle	Gg	95	Equality	3 G 4 B
124.	01/93	"	gg	61	01/53	"	GG or Gg	—	All Gg or Equality	4 G 1 B
125.	01/115	Grizzle	Gg	104	01/120	Blue	gg	59	Equality	3 G 2 B
126.	01/133	"	Gg	90	02/22	"	gg	—	" "	2 G —
127.	01/52	Blue	gg	156	04/10 rev.	Grizzle	GG or Gg	77	All Gg or Equality	4 G —
128.	05/40	Grizzle	Gg	103	04/53	Blue	gg	61	Equality	3 G —
129.	05/119	Blue	gg	65	00/53	Grizzle	GG or Gg	—	All Gg or Equality	1 G 1 B
130.	02/46 (a)	Grizzle	GG or Gg	—	04/27	Blue	gg	91	" "	2 G —
131.	01/14	"	Gg	96	06/87	"	gg	123	Equality	4 G —
132.	05/92	Blue	gg	105	03/9	Grizzle	Gg	84	" "	1 G 1 B
133.	01/121	"	gg	59	04/58	"	Gg	94	" "	— 2 B
134.	05/96	"	gg	105	06/22	"	Gg	119	" "	1 G 2 B
135.	04/13	Grizzle	Gg	96	04/48	Blue	gg	—	" "	4 G 1 B
136.	06/57	"	Gg	118	06/63	"	gg	123	" "	— 1 B
137.	01/121	Blue	gg	59	04/58	Grizzle	Gg	94	" "	2 G —
138.	06/57	Grizzle	Gg	118	05/43	Blue	gg	113	" "	— 1 B
152.	03/5	Silver	gg	83	04/140	Grizzle	Gg	157	" "	1 G 1 B
153.	04/10	"	gg	140	04/10 rev.	"	GG or Gg	77	All Gg or Equality	7 G —
154.	01/14	Grizzle	Gg	96	01/52	Silver	gg	151	Equality	2 G 4 B
155.	08/1336	Silver	gg	148	08/1368	Grizzle	Gg	137	"	2 G 4 B

In only 8 of the other matings did Blues fail to appear, and we may therefore consider that when they did appear the expectation should have been equality as before. Deducting therefore these 8 matings which only produced Grizzles, we have left 33 matings producing 156 young, 63 being Grizzles and 93 Blues. Since only one expectation is possible if both colours appear, we are justified in uniting the figures from these two sets of matings and treating them together. We find, therefore, that in the total we have 52 matings of Grizzle to Blue, which produced 220 young of which 100 were Grizzles and 120 Blues; and this proportion, although not exact, is not unreasonably far from the expectation (Equality), and certainly seems to show a Mendelian basis of inheritance.

If we digest the facts still further, we find that actual equality was reached in only 19 cases, and this by including the odd numbered broods where the deviation was not more than one.

We have, therefore,

		Actual Equality reached in roughly 36 % of the matings.	
Blues outnumbered the Grizzles by more than one in	20 ⁰ / ₁₀	"	
Grizzles " " Blues " "	14 ⁰ / ₁₀	"	
Blues only, appeared in	18 ⁰ / ₁₀	"	
Grizzles only, " "	14 ⁰ / ₁₀	" *	

This, therefore, seems to show that while only a moderate percentage of matings gave the exact Mendelian expectation, the variation to one side or other of the mean is fairly evenly balanced, with however a slight but unmistakable tendency towards an overproduction of Blues: a tendency which was also shown in the Grizzle to Grizzle matings.

Thus, as in the case of the Chequers where we found the Mendelian proportions fairly well maintained, but with a distinct tendency to an overproduction of Chequers, so also in the Grizzles we see a similar tendency to an overproduction of Blues.

There remains for consideration the 8 matings in which only Grizzles appeared. Two of these may be at once dismissed as only one bird was reared, so that we have no hint as to the probable expectation. From the other 6 matings 25 birds were reared, so that there is a reasonable probability of a Blue having appeared were either of the parents heterozygous. Unfortunately for the simplicity of this reasoning, we find on investigating the matter more closely that although in 3 of these matings the same hen was used and we might therefore presume her to be homozygous, yet by her progeny in another mating (Exp. 109) she proved herself to be heterozygous. This then leaves only 3 cases out of 60 in which the Grizzle parent might be homozygous. So that again, just as we found in the Chequers and Blues an overwhelming proportion of homozygous birds, which we attributed to the unconscious selection of breeders, similarly in this case the

* This last calculation is of course exclusive of the 8 matings mentioned above, in which the gametic formula of the Grizzle parent was doubtful.

Exp. No.	♀	Ext. App.	Genetic Formula.	From Exp.	♂	Ext. App.	Genetic Formula.	From Exp.	Expectation.	Result.
153.	04/10	Silver	gg	140	01/30 rev.	Grizzle	Gg or Gg	77	All Grizzles or Equality	7 Gg. 0
195.	650	Blue Chequer	gg	148-B	09/09	Grizzle	Gg	153	Equality	3 Gg. 2 gg
197.	07/6	Grizzle Chequer	Gg	196	08/0	Blue	gg	196	"	4 Gg. 4 gg
198.	07/4	"	Gg	196	08/4	Bl. Chequer	gg	196	"	2 Gg. 3 gg
199.	07/6	"	Gg	196	08/3	Grizzle	Gg	196	Grizzles 3:1	2 Gg or Gg. 0
200.	08/19	Blue Chequer	gg	197	03/22	Bl. Chequer	gg	197	No Grizzles	0. 11 gg
201.	09/533	"	gg	197	09/36	"	gg	198	"	0. 6 gg
202.	09/26	Grizzle	Gg	203	08/13	Grizzle	Gg	196	Grizzles 3:1	9 Gg or Gg. 1 gg
203.	09/24	Silver Grizzle	Gg	198	08/30	"	Gg	197	"	7 Gg or Gg. 2 gg
204.	09/513	Almond Grizzle	Gg or Gg	199	08/27	Al. Grizzle	Gg or Gg	199	All G or 3:1	5 Grizzles
180.	02/46(b)	Grizzle	Gg	—	07/54	D. Mealy	Gg	179	3:1	14 Gg or Gg. 1 gg
181.	08/1322	Silver Grizzle	Gg	154	08/1326	L. Mealy	Gg or Gg	180	All G or 3:1	* 8 Gg or Gg. 1 gg
182.	08/1376	"	Gg	154	08/1351	D. Mealy	Gg or Gg	180	" 3:1	9 Gg or Gg. 3 gg
183.	04/23	Grizzle	Gg	99	09/5408	D. Mealy	Gg or Gg	182	" 3:1	3 Gg or Gg. 3 gg
184.	04/14	"	Gg	96	02/5466	D. Mealy	Gg or Gg	181	" 3:1	1 Gg or Gg. 2 gg
185.	09/4848	"	Gg or Gg	181	09/4845	Grizzle	Gg or Gg	182	All G or 3:1 or Bq.	5 Gg or Gg. 0
186.	09/5435	"	Gg or Gg	180	09/5457	"	Gg or Gg	181	" or 3:1 or Bq.	2 Gg or Gg. 1 gg
187.	09/1	"	Gg or Gg	180	09/4846	L. Mealy	Gg or Gg	182	" or 3:1 or Bq.	6 Gg or Gg. 0
188.	09/4847	Light Mealy	Gg or Gg	181	01/03	Blue	gg	402	All Gg or Equality	6 Gg. 0
189.	09/5467	Blue	gg	182	02/5465	L. Mealy	Gg or Gg	181	"	5 Gg. 0
190.	09/5486	Grizzle	Gg or Gg	182	09/4863	L. Mealy	Gg or Gg	180	All G or 3:1 or Bq.	4 Gg or Gg. 0
191.	09/4843	Dark Mealy	"	180	09/4	D. Mealy	"	182	"	6 Gg or Gg. 0
192.	09/2	Blue	gg	181	09/4862	L. Mealy	"	180	All Gg or Equality	5 Gg. 0

* In this mating 2 almost pure white birds appeared; these have been considered as containing Grizzle owing to the presence of white, but as we are dealing with Meales (see later) they may have been only gg.

number of the heterozygous birds largely predominates, and this is probably due to the fact that Grizzle \times Blue is the commonest form of mating used by breeders to produce Grizzles.

We have no records of matings with 2 extracted (Grizzle-bred) Blues, but of Grizzle-bred Blues to Blue we have made 9 matings (Exps. 139-147). These matings produced 28 birds all Blue in accordance with the expectation.

In order to still further test our hypothesis we have carried out the foregoing experiments (see Table, p. 611).

The result of a scrutiny of these matings is sufficient to prove the Mendelian inheritance of the Grizzle character. In some of this last batch the expectation was well defined; in others—owing to the impossibility of distinguishing homozygous and heterozygous birds—the expectation was open to one or two, or in some cases three, interpretations. In those cases where the expectation was all Grizzles or Grizzles and absence, in proportion of 3:1, and only Grizzles were produced, we have concluded that one of the parents, at least, was homozygous—similarly, if any of the progeny in those cases lacked the Grizzle, we have presumed that the expected result should have been 3:1. On this basis we have tested the results and we find:—

Expectation.	No. of Matings.	Result.
All Grizzles	7	39 Grizzles.
3:1	7	32 Grizzles, 11 absence of Grizzle.
Equality	3	9 Grizzles, 9 absence of Grizzle.
No Grizzles	2	18 absence of Grizzle.
Equality or 3:1.....	2	5 Grizzles, 1 absence of Grizzle.

This last set of matings places therefore beyond doubt the Mendelian inheritance of the Grizzle character.

In the summary given above we have, however, left out Exp. 180, in which with an expectation of 3:1 or all Grizzles, 14 Grizzles and one pure Blue were produced. At the present moment, we can offer no reason for this considerable deviation from the expected result.

Grizzles and Chequers.

The Grizzle character is dominant to the Chequer, although, in almost every case, the heterozygotes may be easily recognised.

To test this inheritance we have made the following matings (see Table, p. 613).

These matings show fairly clearly the mode of inheritance, but from the smallness of the numbers the proportions of the different colours are not always in exact accordance with the expectation. It may be further noted that although, from the above reason, certain expected colours have as yet not occurred, on the other hand no unexpected colours or combinations have appeared. Thus we see that in Experiments 200 & 201 the recessive Chequers gave us, as expected, 14 Chequers to 4 Selves, and *no* Grizzles; in Experiments 202 & 205 the pure Grizzles gave us, 11 Grizzles to 1 Self, and *no* Chequers. These two latter

Grizzles and Chequers.

Exp. No.	♀	Ext. App.	Gametic Formula.	From Exp.	♂	Ext. App.	Gametic Formula.	From Exp.	EXPECTATION.	RESULT.
									CG C G S	CG C G S
179.	08/72	Red Chequer	Xxgg	173	04/11	D. Mealy	xxGg	.....	1 1 1 1	- 3 1 1
193.	08/1558	"	Xxgg	—	08/1313	"	xxGg	135	1 1 1 1	- 2 1 2
194.	05/4	"	Xxgg	—	09/5470	"	xxGg	193	1 1 0 0	2 2 - -
195.	08/1525	"	Xxgg	—	09/5888	"	xxGg	155	1 1 1 1	2 2 - 4
196.	650	Blue Chequer	Xxgg	14 S-B	06/69	Grizzle	xxGg	153	1 1 1 1	2 1 1 1
197.	07/b	Grizzle Chequer	XxGg	196	08/c	Blue	xvvg	196	1 1 1 1	1 4 2 -
198.	07/a	"	XxGg	196	08/d	Blue Chequer	Xvvg	196	2 2 1 1	2 2 - 1
199.	07/b	"	XxGg	196	08/13	Grizzle	xxGg	196	2 1 2 1	2 - - -
200.	08/19	Blue Chequer	Xxgg	197	08/22	Blue Chequer	Xvvg	197	- 3 - 1	- 10 - 1
201.	00/533	"	Xxgg	197	08/36	"	Xvvg	198	- 3 - 1	- 3 - 3
202.	08/26	Grizzle	xxGg	206	08/13	Grizzle	xxGg	196	- - 3 1	- - 9 1
203.	08/24	Silver Grizzle	XxGg	198	08/30	"	XxGg	197	9 3 3 1	- 2 7 -
204.	08/27	Chequer Grizzle	XxGg	199	09/543	Chequer Grizzle	XxGg	199	9' 3 3 1	- - 5 -
205.	08/23	Grizzle.	xxGg	197	08/20	Grizzle	xxGg	197	- - 3 1	- - 2 -
206.	08/14	Blue Chequer	Xxgg	14 S-B	08/30	"	XxGg	197	2 2 1 1	- 1 1 -

X, x=Chequering and its absence; G, g=Grizzling and its absence. CG, C, G, S=Chequer Grizzle, Chequer, Grizzle, and Self.

(Exps. 194 & 195 were specially undertaken to produce a certain blend of CG (called Almond Grizzle) and for that purpose ♀s showing "kifeyness" were chosen; in Exp. 193 the ♀ showed no "kifeyness" and no Al. G. appeared.)

matings (Exps. 202 & 205) may be compared with Exps. 203 & 204 *, matings of heterozygote Grizzles, where two Chequered birds turned up, although the whole number bred (12 birds) was far too small to give any hope of an approximation to the expectation being attained. Many of the Grizzles in these matings are very white, a factor which would tend to conceal the Chequer markings if present. It is more than likely therefore, that owing to this, some of these so-called Grizzles are in reality Grizzle-Chequers. Taking the Grizzles and Grizzle-Chequers (of Exps. 203 & 204) together, the expectation is 12 Grizzles and Grizzle-Chequers, 4 Chequers and 2 Self, and our result, 12 Grizzles and Grizzle-Chequers and 2 Chequers, is reasonably near the anticipation. The expectation in Experiments 179, 193, 195, 196 & 197, was an equality of Grizzle-Chequers, Chequers, Grizzles and Selves, and the result 5 Grizzle-Chequers, 12 Chequers, 5 Grizzles, 8 Selves, the only real discrepancy here being the overproduction of Chequers. This apparently merely confirms the conclusion come to in an earlier part of this paper, p. 607, which showed that there is apparently some factor which overrides the Mendelian inheritance, and leads to an increase in the number of Chequers produced.

Mealies.

A 'Mealy' may best be described as a Red Grizzled Pigeon showing Blue. The general appearance may be seen by reference to Plate XXV, and it should be noticed that it has the red bars and white flights characteristic of some varieties of red pigeons. When dealing with the Grizzle-character (G) we had to consider its relation to White, and we came to the conclusion that the White was not a colour factor complementary to Blue, but a separate allelomorph; so that the real gametic formula of a grizzled bird was made up of a compound allelomorph containing three characters—blue, white, and grizzling (B, W, G). For practical purposes, however, the W & G combine in their inheritance, and thus in the cases we have been considering they have, for convenience, been regarded as a single character (G).

In considering the inheritance of the Mealies, however, we must again pause to consider whether the factor for Red is to be treated as a colour factor, complementary therefore to Blue, or as complementary to the factor for White, or yet again as a separate allelomorph.

At first sight it would seem natural to consider it an alternative colour to Blue, but if this be the case a certain number of Self Reds should have appeared in our matings. None, however, were produced, though a certain number of Blues have been reared.

The same argument, though in a lesser degree, should hold good if it had an inheritance of its own, and we are thus driven to the conclusion that the Red is a complementary factor to the White. We have also had certain aberrant results (not dealt with in this paper) which point to a curious connection between these colours.

* This pair has produced both CG and pure Chequers this year (1911).

Finally, the study of the Mealy itself bears out this contention. A dark 'Mealy' differs from a dark 'Grizzle' in the fact that the white portions of the latter are replaced by red and the flights and tail instead of being black are white. In the Grizzles we noted that there was a great tendency for the white to increase till an almost pure white pigeon, showing only a few coloured feathers, was produced. Matings of Mealy to Mealy show an increase of the white, as is the case with Grizzles, till we eventually get a white bird showing a few coloured (Blue or Red) feathers. We must then come to the conclusion that in Mealies it is the white that is replaced by red, and *not* the blue, and therefore that a Mealy is a Grizzled bird in which the white is wholly or partially replaced by red.

We have had to go into this matter thoroughly as it offers certain difficulties, which cannot be entirely cleared up till the relationship of white and red have been further investigated; nevertheless the results of our experiments will offer no difficulty if the red is considered as an alternative factor to the white.

In our experiments with Mealies, one character has been present in all the matings, namely Blue, or in its dilute form Silver; we may therefore dismiss it from our calculations.

The only Chequer which appears (the one in fact by which the red colour was originally introduced) is shown in Exp. 179; the only Grizzle bird from that mating (Mealy ♂ 54), whose descendants form the large bulk of the Mealies, emphasizes the truth of his inheritance, since no chequered bird has appeared in spite of the large number bred.

The Grizzle character in the Mealy or Mealy bred birds we have already dealt with (Exps. 180-189, p. 611). The question therefore left us to consider in dealing with the Mealy inheritance is the question of Red and White. Red is apparently dominant to White, and in consequence a Mealy is dominant to a Grizzle.

The following matings (see Table, p. 616) show the inheritance of this character. It must be borne in mind that W & w are in this case practically equivalent to G & g in the earlier part of this paper. According to our present knowledge, when the Grizzle character meets with either white or red they combine in their inheritance to give either a Grizzle or a Mealy.

Taken as a whole, it will be seen that the results come remarkably near the expectation. In 5 of the 11 matings, in spite of the small numbers, the results *exactly* bear out expectations; and in all the others, with the exception of Exp. 181, the results are sufficiently near to leave little doubt that a continuance of the mating would have made them correct.

Taking the expectations and results together but omitting Exp. 181 we get:—

Expectation	2 M.	1 G.	1 S.	No. of Matings	4.	Result	18.	10.	9
"	2 M.	2 G.	0 S.	"	"	5.	"	11.	8. 0

in both of which sets there is a slight tendency to fewer

Exp. No.	♀	Ext. App.	Gametic Formula.	From Exp.	♂	Ext. App.	Gametic Formula.	From Exp.	EXPECTATION.			RESULT.		
									Mealy	Grizzle	Self	Mealy	Grizzle	Self
180.	02/46 b	Grizzle	Ww	—	07/54	D. Mealy	Rw	179	2	1	1	9	5	1
181.	08/1322	Silver Grizzle	Ww	154	08/1326	L. Mealy	RW	180	2	2	0	7	2	1
182.	08/1376	"	Ww	154	08/1354	D. Mealy.	Rw	180	2	1	1	7	3	3
183.	04/23	Grizzle	Ww	99	09/5468	"	Rw	182	2	1	1	2	1	3
184.	04/14	"	Ww	96	09/5466	"	Rw	181	2	1	1	—	1	2
187.	09/1	"	Ww	180	09/4846	L. Mealy	RW	182	2	2	0	2	2	0
188.	09/4847	L. Mealy	WR	181	09/63	Blue	ww	62	2	2	0	3	3	0
189.	08/5467	Blue	wr	182	09/5465	L. Mealy	RW	181	2	2	0	2	1	0
190.	09/5486	Grizzle	rw	182	09/4863	"	RW	180	2	2	0	3	0	0
191.	09/4843	D. Mealy	Rw	180	09/4	D. Mealy	Rw	182	2	0	2	6	0	0
192.	09/2	Blue	rw	181	08/4862	L. Mealy	RW	180	2	2	0	1	2	0

W = White = Grizzle; R = Red = Mealy; w & r their absence.

Dark Mealy = presence of R and absence of W.

Light Mealy = presence of both R & W.

Blue = Self-colour, *i. e.* absence of both R & W.

Grizzles than one would expect. So that here again, although the numbers are small, the Mendelian proportion seems to be upset by a slight tendency in a definite direction.

The occurrence of a pure Blue (no. 2) in Exp. 181 is the *only* instance throughout the whole of our matings in which a colour, other than one which was expected, has appeared. Possibly the male parent of this mating (1326), although unlike his brother (1354) in external appearance, had in reality the same gametic formula. Such an occurrence would not be without precedent, as Mr. Staples-Browne instanced a homozygous Blue which showed a certain amount of white, and this ought to have indicated a heterozygous bird. The difference between these two birds (*i. e.* presence of white) is of the same nature, and in support of this suggestion the result of the mating—7. 2. 1—seems to be following on the same lines as Exp. 182.

There is one other possible suggestion for this abnormal result, and this is that the White or Red character may not have been inherited with the Grizzle.

The full formula of the parents on this basis is :—

♀ BBcd Gg [Ww]—♂ BBcd Gg [RW].

Now if the Grizzle has been independently inherited, we might get BBcdgg [RW, WW, wR, Ww] as the formula of one of the offspring, and the last character [RW etc.] might not in the absence of G be able to show itself, and this would give us what we got, namely a pure Blue. The result of the mating of this self-coloured bird (Exp. 192) throws no light on this, for if, as is quite possible, her mate was a homozygous Grizzle, no selfs would appear.

It must be understood that these are merely possible explanations, of which we are inclined to favour the first, but at present we have no definite proof in support of either.

For the rest, we claim that our hypothesis is so closely borne out by the facts that it may be accepted till further work confirms or disproves it : and until we are clearly able to differentiate between those characters which follow the Law of Mendel and those which are apparently governed by other laws.

In this paper we are only touching on the fringe of colour inheritance in Pigeons, as there still remains the question of Black, Dun, Red, Yellow, and White inheritance, on which we are at present continuing our researches. Our work, however, emphasizes the fact that there are three important problems which the Mendelian hypothesis fails to meet :—

- (i) The differences of shades in the same colour ;
- (ii) The predominance of one sex in certain colours* ;
- (iii) The gradual increase of the white in Grizzles and Mealies in successive generations ;

* This most interesting question has not been dealt with in the present paper, as we have not yet fully investigated the results ; but we may mention that a large proportion of the White Grizzles are ♀'s, and in the Light Mealies by far the larger number are ♂'s ; we have also bred a certain number of Cream Mealies, and these have all been ♀'s.

and in addition to these the *apparently* large predominance of homozygous Chequers and heterozygous Grizzles.

These questions have been very much before us during the whole of our experiments, as indeed must be the case, for they cannot fail to bring themselves to the notice of every practical breeder.

At the present moment we do not consider it advisable to bring forward any attempted answers to these questions. Much more work yet remains to be done among the other colours, and until we know more of their inheritance any attempt to solve these problems would be premature. On the other hand, we are not without hope that the further experiments in which we are at present engaged may help to throw some light on these perplexing problems.

Summary.

This paper may strike a reader as having for its main object the confirmation of the Mendelian Laws; that, however, is by no means the case. Realizing that many details of inheritance did not entirely accord with the Mendelian theory, our object has been to extract, so to speak, from the results obtained by mating on Mendelian lines, that portion of them which clearly shows the Mendelian inheritance. The residue must, we submit, have been brought about by some law or series of laws, which overrides and modifies (externally at all events) the expected Mendelian results. By means of this extraction we are able to see the effect of that law or laws untrammelled by the effects of inheritance as ruled by the Law of Mendel, and thus we have been brought slightly nearer to an understanding of them.

Now this paper deals with the Mendelian inheritance of the characters considered; consequently all details of shades of colour, predominance of one sex in certain colours, and several other similar matters have been entirely omitted.

On the other hand, certain points such as the superabundance of Chequers in our Chequer matings and of Blues in the Grizzle and Blue matings, have had to be brought forward and the results are, we hope, sufficiently conclusive to prove to our readers that although the characters dealt with follow in the main on the lines of the Mendelian inheritance, yet it is equally certain that there is another factor which is able to dominate and influence that inheritance.

So far as the matter has been dealt with in this paper there is no evidence to show that the gametic inheritance has been affected. Except in one doubtful case (Exp. 181) we have not in the course of all our matings bred a single bird that was not a possible result of the mating under the strictest expectation of the Mendelian theory. What, however, we have been able to show is, that in certain cases a consistent deviation from the expected proportions occurs. It would thus seem at first sight as

if some factor exists which has the power to influence but not to alter the gametic inheritance.

The Mendelian conclusions reached in this paper may be briefly summed up as follows :—

- (1) Silver is dilute Blue.
- (2) Blue is dominant to Silver.
- (3) Chequering is dominant to its absence (*i. e.* a Self-colour).
- (4) Grizzling is dominant to its absence (*i. e.* a Self-colour).
- (5) Grizzling is dominant to Chequering; the impure dominants may however sometimes be easily distinguished.
- (6) A Mealy is a Grizzled bird with the White wholly or partially replaced by Red.
- (7) Red in a Mealy is apparently dominant to White, and hence a Mealy is dominant to a Grizzle.
- (8) White and Grizzling when they have met combine together and have a common inheritance.
- (9) Red combines with Grizzling in the same way as does White.

EXPLANATION OF THE PLATES.

PLATE XXIII.

- Fig. 1. Blue Pigeon.
 2. Silver Pigeon.
 3. Chequered Pigeon.

PLATE XXIV.

- Fig. 1. Dark Grizzled Pigeon.
 2. White Grizzled Pigeon.
 3. Grizzle and Chequer (Almond Grizzle) Pigeon—in nest feathering, showing adult feathers appearing on the wing-coverts. (Note chequering on the adult wing-coverts.)

PLATE XXV.

- Fig. 1. Dark Mealy Pigeon.
 2. Light Mealy Pigeon.
 3. White Mealy Pigeon. (Tricolor.)

PLATE XXVI.

Feathers showing details of pattern-markings.

- Fig. 1. Chequered feather.
 2. Dark Grizzled feather.
 3. Grizzle-Chequer feather, adult plumage, as shown in dark wing-coverts, Pl. XXIV, fig. 3.
 4. White Grizzled feather.
 5. Light Mealy feather. (Note white, red, and blue in some barbs.)
 6. Dark Mealy feather. (Note absence of white.)

EXHIBITIONS AND NOTICES.

April 4, 1911.

Dr. HENRY WOODWARD, F.R.S., Vice-President,
in the Chair.

Sir E. RAY LANKESTER, K.C.B., F.R.S., F.Z.S., exhibited a special Supplement of the 'Field' newspaper dealing with the British non-migratory Trout, and called attention to this new medium for the publication of scientific observations requiring illustrations.

Dr. R. T. LEIPER, F.Z.S., gave a demonstration of Nematode parasites obtained from animals in the Zoological Gardens during the year ending November 1910.

The collection contained a number of new forms, of which a systematic account will be published later. Among the more interesting of the known forms were *Rictularia plagiostoma* from a Palm-Civet, a number of species of *Polydelphis* from various Pythons, *Dicheilonema horrida* from the South American Ostrich, and *Dictyocaulus filaria* from the lungs of Sheep.

It was noticed that whereas intestinal parasites were almost wholly collected from animals that had not lived in the Gardens for more than six months, those of which the normal habitat and food were the internal tissues of the host occurred in animals that had been confined in the Gardens for several years. Thus, an undescribed *Filaria* was found in a Lemur after four years', and *Filaria australis* in a Wallaby after two and a half years' captivity.

In all these cases the number of parasites obtained was small, and could have had little or no effect upon the health of the host. There was a remarkable preponderance of female forms.

From these observations it appeared that the change of food and general conditions obtaining in the Gardens were unfavourable to the continued existence of the intestinal parasites an animal may harbour on its admission. The number of cases of auto- and re-infection during captivity was strikingly small, and bore testimony to the cleanly surroundings in which the animals were kept. In four cases only was there evidence of the occurrence of accumulative infection in the Gardens:—

1. A number of Giant Toads died from lung infection with *Rhabdias bufonis*.
2. The Wolves appeared to be heavily infected with *Ascaris canis*.
3. A Sheep died from pneumonic condition resulting from an intense infection with *Dictyocaulus filaria*.
4. The Tortoises had Oxyuriasis.

In all these cases repeated infection undoubtedly had followed

from contamination of food and drink with fæces containing eggs of the parasite. The infection could be eliminated by steam sterilisation of the cages, or still more easily by changing the species of animal living in the particular paddocks or cages, for Helminthes were often peculiarly selective as regards their hosts, and those flourishing in one animal sometimes found it impossible to continue their life even in closely allied forms.

Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens, exhibited the newly born young of the Masked Palm-Civet (*Paradoxurus larvatus*), which had been born in the Gardens from a pair from Szechuen, presented to the Society by Mr. Thurlow Lay, and remarked that, although the specimen had died soon after birth, two other individuals composing the litter were alive and likely to do well. This was the first occasion on which the species had bred in the Gardens. The coloration of the

Text-fig. 147.



Inner aspect of abnormal left fore-leg of a newly born Masked Palm-Civet
Paradoxurus larvatus.

p, pad; *s*, strip of naked skin; *c*, claw.

young resembled in a general way that of the adult, but was of a more generalised type, the black and white pattern of the head being less emphasized and the general colour of the body greyer with less yellow; the greater part of the tail and the lower portion of the limbs were sooty grey, the throat, chest, axillæ, belly, and the inside of the thighs being white. Of special interest was the presence of a pair of ill-defined dark stripes on the back and of very indistinct traces of pattern on the sides of the body. The

head, which had the eyes and ears closed, was shaped very much like that of a wolf-pup. The tail was short-haired and tapering and as long as the body from the fore part of the shoulders backwards.

Special attention was drawn to a peculiar abnormality of the left fore-leg (text-fig. 147). The humerus appeared to be of normal length, but the lower arm was quite short, and there was no distinct elbow-joint; the paw, although freely articulated at the wrist, was axially rotated outwards so that its plantar surface looked inwards. It was furnished with a single large pad representing the large pad of the normal foot, and was armed with a terminal claw, a thin strip of naked skin passing from the claw to the pad.

[*Note added July 17th, 1911.*—The two specimens of the litter that survived grew with great rapidity as compared with dogs and cats, and almost equalled the size of their parents when three months old. Their eyes, however, opened, as in the former animals, about the ninth day from birth.]

Land Tortoises in the Seychelles.

THE SECRETARY read the following dispatch from the Governor of the Seychelles, a copy of which had been kindly sent him by the Secretary of State for the Colonies, for communication to the Society.

Government House,
Seychelles,
1st June, 1910.

MY LORD,

In view of enquiries made from time to time regarding the conservation of the breed of land tortoises of the islands in the Indian Ocean, I have the honour to append some notes condensed from the entries in the stud-book of the herd at Government House, Mahé. This book was opened by me soon after my arrival here in 1904, and contains records of the annual measurements of the specimens under my observation and of their habits.

2. In June 1904 I found a herd of 42 adult land tortoises, and 17 young ones hatched out in 1902 and 1903; these were duly marked, numbered and measured, and the particulars entered up in a new stud-book. The bulk of the herd had been purchased for the Government in 1892 from the late Mr. Nageon de l'Estang of Val des Prés, a proprietor of ancient family in the district of Anse Aux Pins, Mahé. The animals were then transferred to Curieuse Island, the property of the Crown, and were brought back to Government House in 1902.

3. In addition to this herd, there are two large males: No. 1. "Gordon," presented by the late General Gordon (of Khartoum) when he was stationed in Seychelles in 1881 after his transfer from the Cape; this is the largest land tortoise in Seychelles, and measures over the surface of the carapace 4' 9½" and 4' 8". The

plastron measures $3' 9'' \times 2' 9''$. This is undoubtedly *Testudo elephantina* according to Dr. Günther's monograph. The next largest, No. 2. "Spurs," was presented by Mr. Spurs, now of Europa Island, a French possession in the Mozambique Channel: I am indebted for many of my most curious notes on the habits of all varieties of sea turtles and land tortoises to this gentleman, who is an educated man trained in habits of observation and has spent all his life among the islands of the Indian Ocean. The present dimensions of "Spurs" are $4' 5'' \times 4' 4''$ on the carapace and $3' 7'' \times 2' 5''$ on the plastron: he has grown slowly in breadth since 1904 but not in length. This remarkably fine specimen (the finest which Mr. Spurs has seen) is not of the *elephantina* variety, and resembles the *Testudo daudinii* of Dr. Günther's monograph.

These are probably the finest specimens living of their race. My recollection is that the *Testudo elephantina* which died at Colombo in 1900, of a recorded age of 155 years, was of larger dimensions. The large specimen at St. Helena was measured by Admiral Sir J. Durnford in 1907 as $4' 6''$ "fore and aft," but it is not certain whether this measurement included only the shell of the back.

4. The adult females, which are readily distinguishable in shape, are smaller than the males. The largest specimen in the collection (No. 5) reached its present dimensions— $3' 8'' \times 3' 10''$ along the carapace and $2' 8'' \times 2' 1''$ along the plastron—in 1906, and has not grown during the last three years. Several others have rather smaller dimensions and have not grown since 1904.

The breeding season extends from January to April: the females carry their eggs for about 10 weeks and lay them in holes dug out by their hind legs and then covered over. The eggs in each nest vary in number from 9 to 25 and are white, round, and of the size of a lawn tennis ball. There may be two nests made annually by one female. Sea turtles lay a much greater number of eggs, *e. g.*, the green turtle 250 eggs at a time, and the hawks-bill turtle 100 to 150.

5. The young hatch out in about 120 to 130 days and work their own way out of the ground. At the Government House "parc aux tortues" about half of the eggs are unfertile; but in some years of drought, very few young ones appear, being unable (probably) to work their way up. They grow fast if well fed, and at four years old measure $1' 6''$ to $1' 10''$ in length and breadth of carapace. It is said that they attain full growth in 25 years. It is a local custom to mark off a young one at any birth in the family and to eat it at the child's wedding day. The meat is palatable and the liver is held to be a delicacy.

6. The number of young ones secured from 1904 to 1909 was 168; they are liable to be destroyed by rats before their shells harden. In a wild state at Aldabra practically all the young are destroyed by florentins (cranes), rats, and wild cats.

7. Through the courtesy of Admiral Sir John Durnford and Captain Dumas, R.N., six specimens from this herd have been presented to various institutions, *e. g.*, Groot Schuur, Pretoria, and the Zoological Society of London.

8. Owing to the difficulty in providing food for the increasing herd in the enclosures at Government House, I have drafted off—in March and May 1910—4 adult males and 18 adult females and 27 young ones of the “récoltes” in 1903, 1904 and 1905 to Long Island, a Crown property used as a quarantine station, where they are placed under the charge of the Guardians and where there is an ample supply of food.

9. “Gordon” shows likes and dislikes and is rather combative, having successfully bitten some visitors who presumed on his apparent lethargy, but generally the land tortoise shows little intelligence.

10. There have been no deaths among the adults during six years in the enclosures at Government House, but one male has been killed by a fall at Long Island, where they have shown themselves to be capable of swimming. The remains of tortoises found in the pits in the coral formation of islands in the Aldabra Group points to the falling into pits as one of the principal causes of death. They live apparently to an extreme old age—probably for 200 years. No plan will effectively prevent the final extinction of these curious survivals in a wild state in their natural habitats. The archives of Seychelles, Vol. i., published in 1909, are full of references to their size and number in Mahé and Praslin, where they were speedily destroyed by the early settlers. But their future existence is guaranteed by the fact that they breed in captivity and that several large herds besides that at Government House are kept and well cared for. It is a guarantee for their being taken care of that there is a sale for living specimens for zoological collections.

11. The best book in English on the subject is a monograph entitled “Gigantic Land Tortoises” by Dr. Günther, published for the British Museum about 1878. The names of the best known varieties of the larger tortoises and turtles are as follows:—

Of Aldabra: *Testudo elephantina*.

Of Galapagos: *Testudo nigra*.

Of Greece: *Testudo græca*.

Box Tortoise of Madagascar: *Pyxis arachnoides*.

Box Tortoise of North America: *Cistudo carolina* (Brer tarapin).

Lettered Tortoise of North America: *Emys sculpta*.

Green Turtle: *Chelone mydas*. (The edible variety much consumed in Seychelles.)

Loggerhead Turtle: *Thalassochelys caretta*. (I do not know this species by sight.)

Hawksbill Turtle: *Chelone imbricata*. (The tortoise-shell variety.)

I have, etc.,

THE RIGHT HONOURABLE
THE SECRETARY OF STATE
FOR THE COLONIES.

(Signed) W. E. DAVIDSON,
Governor.

A Bee-disease due to a Protozoal Parasite (Nosema apis).

Dr. H. B. FANTHAM, F.Z.S., and Miss ANNIE PORTER, D.Sc., exhibited some diseased bees and combs infected with a minute pathogenic protozoal parasite, apparently the same as *Nosema apis* found by Zander in diseased bees in Bavaria. Microscopic preparations and drawings of the parasite, *Nosema apis*, were also shown, as well as healthy bees and combs in contrast. The material exhibited was obtained from Cambridgeshire and Hertfordshire in March, 1911. Some of the infected combs were brown in colour instead of the normal yellow (combs of the same age being compared), while the infected bees suffered from a sort of dry dysentery which rapidly proved fatal.

The pathogenic agent of this dry dysentery, *Nosema apis*, formed thousands of minute spores which fouled the hive, while infection was probably spread to new hives by hungry, weakly bees attempting to enter healthy hives. The spores, about 2 to 3μ by 4 to 6μ , were the resistant and cross-infective stages of the Protozoön. The parasite *Nosema apis* was closely allied to that of pébrine, the silkworm disease due to *Nosema bombycis*.

The trophozoite and pansporoblast stages of the *Nosema apis* had been observed in the gut-epithelium of the bee. Some spores with polar filaments extruded had also been found. It was very probable that the young, growing and multiplicative stages of the parasite were capable of killing the bees before the formation of spores had been attained, for dead bees were often found in which only young stages of the parasite could be detected, occurring especially in the chyle-stomach and intestine. Like *N. bombycis*, the bee-parasite was possibly capable of hereditary infection, as infected bee-larvæ and a dead infected queen had been found and examined. Maassen had recently found infected drones in Germany, but the infection in drones was stated to be limited to the intestine.

That *Nosema apis* was fatal to bees and allied Hymenoptera had been shown by the exhibitors by feeding healthy hive-bees, mason-bees, and wasps with honey infected with *Nosema* spores; also by placing hive-bees dead of the disease among healthy hive- and mason-bees and wasps, and by direct contamination of healthy bees with infected faecal matter. In each case the insects experimented upon succumbed to the effects of *Nosema apis*. In Nature the method of infection is probably contaminative, healthy bees becoming infected by swallowing the spores of the parasite.

It should be noted that the virulence of the parasite appeared to vary in bees at different times of the year and in different localities. Bad seasons are usually followed by increase of disease. Some bees became chronics, forming reservoirs of spores and so acting as parasite-carriers.

The only certain destructive agent of the Microsporidian spores was fire, and all infected bees and hives, and any débris therefrom should be most carefully burned.

In the opinion of the exhibitors, the Microsporidian parasite, *Nosema apis*, had been responsible for much of the bee-disease recorded in this country since 1906, especially in 1906, 1907, and 1911. The exhibitors first noticed the parasite in 1906 in diseased bees obtained from the Isle of Wight; its full significance was grasped in 1907, but owing to the difficulty of obtaining material the exhibitors' results were not published. As much attention was now being directed to "bee-disease," the exhibitors briefly recorded their observations. It was not asserted that microsporidiosis was the only disease of bees current in Great Britain at present, as Dr. Malden had investigated a bacillary infection in bees, the parasite being called *Bacillus pestiformis apis*. "Foul brood" also was a well-known and separate disease.

Microsporidiosis (due to *Nosema apis*) had probably been introduced from the Continent into British apiaries.

Other parasites found in bees—chiefly in the gut—by the exhibitors were various species of Gregarines, a Flagellate apparently belonging to the genus *Crithidia*, a new Amœba (*Entamœba apis*) very like *Entamœba coli* of the human intestine, a Spirochæte, and various Fungi.

PAPERS.

29. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received and Read April 4th, 1911.]

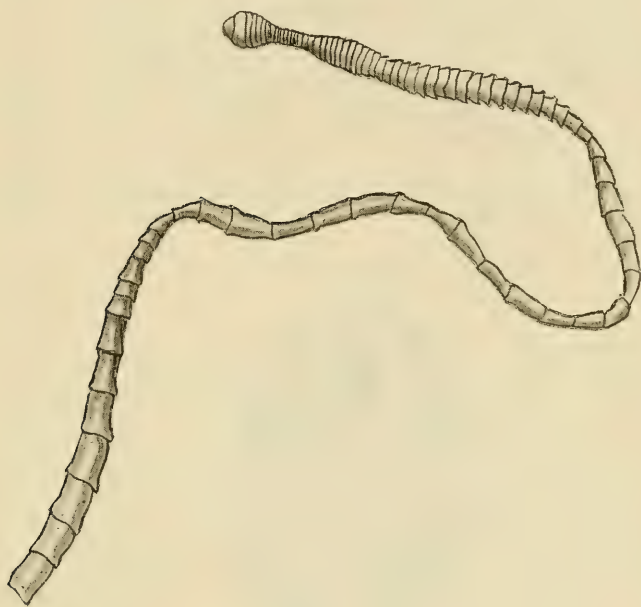
(Text-figures 148–159.)

I. ON SOME MAMMALIAN CESTOIDEA.

I propose to communicate to the Society from time to time reports upon the species of Cestoidea which have been collected, and are being at present collected, from animals which have died in the Society's Gardens. The collection in my hands is the result of nearly two years' examination of (necessarily) a great number of animals, but does not contain as yet a very large number of species, either of known forms or of those which I believe to be undescribed. Tapeworms are by no means so common as other parasitic worms, particularly Nematodes, which are most abundant among the animals in the Gardens. Of the forms which I have identified as belonging to well-known species, I propose at some date to give a complete list, which will be useful, not only as indicating the species which are most abundant in the captive animals, but as extending the range of hosts. At present I could hardly give a long enough list to

warrant publication in the 'Proceedings.' The new forms, however, I intend to describe, a few at a time, as soon as I can give a sufficiently comprehensive account of their structure to make such publication useful. The present communication contains a fairly full anatomical account of three new species, of

Text-fig. 148.

*Oochoristica* sp., $\times 2$.

two of which I have abundant examples for study. Of the third, I have been able to study two specimens only. But I have been fortunate enough to fill up most of the descriptions which are chiefly required to determine its systematic position with accuracy.

On a Species of Oochoristica.

I refer a number of individuals from the Lesser Anteater, *Tamandua tetradactyla*, to this genus, for reasons which will be apparent in the course of the following account of this Tapeworm, and which are summed up at the end of the description in considering its affinities. I believe, however, that the present species is to be regarded as a new one, though it undoubtedly comes very near to *Oochoristica wagneri*, described by von Janicki from the same Edentate four or five years since*. The reasons for this

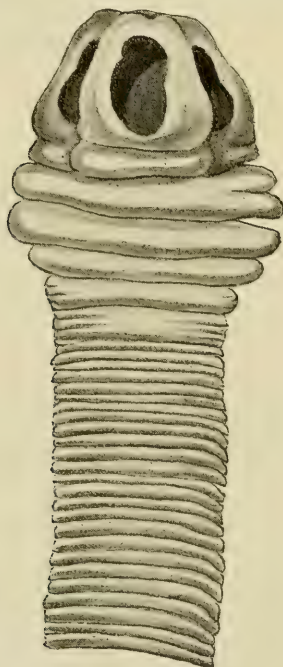
* v. Janicki, "Studien an Säugetiercestoden," Zeitschr. f. wiss. Zool. lxxxi. 1906, p. 5.

opinion will also be given later, after I have detailed the characteristics of these worms.

As is the case with other species of *Oochoristica*, the scolex of the present species is entirely unarmed and without rostellum. I have studied this and other regions of the body not only by inspection with a lens and the microscope of specimens in spirit mounted entire in Canada balsam, but also by means of transverse and longitudinal sections. I find that the rostellum is not represented by the smallest vestige that can be recognised. The anterior end of the head or scolex is simply slightly and uniformly convex, the convexity representing a large circle and, therefore, not to be described as a papilla. The suckers appear to stand out rather from the scolex, and are somewhat long in shape with a narrow and slit-like orifice.

The general aspect of the scolex itself does not recall that of such other members of the genus *Oochoristica* as have been

Text-fig. 149.



Scolex and a few anterior proglottides of *Oochoristica* sp.

figured, excepting in its tetragonal form in section. It is, moreover, rather unlike that of other *Tetracotylea*. When viewed superficially with a lens, or under a low power of the microscope,

the scolex appears to be of an oval contour, passing thus gradually into a neck, which is at first narrow and later widens out. There is nothing abnormal about the shape of such a scolex. A close examination, however, shows that such a description would be quite incorrect. For the scolex itself is in reality almost semi-circular in outline, and its outlines are carried on on either side by the neck of the worm, which is, to begin with, rather wider even than the thickest part of the scolex. This is clearly to be seen in text-fig. 149. It seems to be imbedded in the first segments of the strobila, like an egg in an egg-cup. Thus the true scolex is very short. The widening of the strobila, for a space of some five or six proglottides, suggests the commencing formation of a "pseudoscolex," such as is further developed in, for example, *Thysanocephalum crispum* *.

The first steps in the formation of a pseudoscolex might well be imagined to occur in some such way as is shown in the anterior proglottides of the present species. There is, however, no further indication of the formation of a pseudoscolex. The anterior proglottides are precisely like those which follow, save in their greater diameter. The figure also suggests that the scolex is retractile within the first part of the strobila. In a sense this is the case. Longitudinal sections through the scolex and the commencing strobila show a bulging of the latter. There is a plain demarcation between scolex and strobila, and not much curving back of the anterior proglottides when thus viewed. That the scolex itself may be extended to a greater length is possible enough. And yet in seven or eight examples which I examined there was an identity of structure in this and other particulars. It is to be noted, therefore, that this species, unlike *Oochoristica tetragonocephala*, has no neck †, as, indeed, was asserted of the latter by Diesing, but denied later by Lühe and Janicki.

In examining the scolex mounted entire, after clearing with oil of cloves or in alcohol previous to mounting, the suckers are by no means so conspicuous as in other Tapeworms. The slit-like orifice can, indeed, be detected, but it is rather shrouded and dim. The reason for this is apparent when the scolex is studied by means of transverse sections, in which the relations to the head are shown. It will be there seen that, except for the small orifice of the sucker, that organ is not by any means entirely external in situation; the sucker is, in fact, covered by a thickish layer of the ordinary parenchyma of the body. It is thus imbedded in the head, and represents a still further pronounced sessile condition of the sucker, which (*inter alia*) distinguishes the Tetracotylea from the Tetraphyllidia. At the same time, the sucker retains its cup-like form, the two edges although in

* Cf. Benham in pt. iv. of 'A Treatise on Zoology,' ed. Sir E. Ray Lankester, p. 121, fig. xvii. 2.

† Unless, indeed, the anterior bulging part of the body of the worm is the neck. But as it shows transverse furrows (text-fig. 149) I do not think that this is the case.

contact not uniting, thus leaving a slit-like orifice, which is dimly seen when the scolex is viewed in its entirety.

The general aspect of the body is like that of other Tapeworms, in that the anterior region is much narrower than the posterior region, where the segments are in every way larger. In the present worm this distinction is very marked, and the posterior segments are rather more than oval in section, and approach a circular contour. At the same time, this region of the body is much stronger and thicker in every way than the anterior region, so that there is a tendency for this part to become broken off. There seems to be a rather sudden transition between the anterior and the posterior regions. The posterior region of the body, in fact, has quite the contour of an Earthworm, and entirely lacks the flattened appearance of a typical Cestode. The cause of this differentiation is doubtless to be sought in the swelling caused by the dissemination of the ripe eggs through the medullary layer. It is, in fact, in the posterior region that the uteri of the proglottides have entirely disappeared, and are replaced by eggs scattered singly through the parenchyma of the middle layer of the body.

This state of affairs was, however, only to be noted as existing in a marked fashion in the larger and, therefore, presumably more fully mature examples of the worms. Fresh specimens reached about 60 mm. in length, though in none did the breadth of the body exceed 2 mm. Indeed, 1.5 mm. was the prevalent diameter. In smaller worms of 30–40 mm. length, the posterior proglottides were by no means so swollen and remained comparatively flat. So far as can be seen from an examination of the dozen or so of specimens of this worm which I have in my possession, there is no detaching of proglottides. In the first place, I always found the terminal proglottid in its place, and to be distinguished from the others by its oval posterior boundary interrupted by a large orifice (apparently of the water vascular canals) highly suggestive of a proctodæal invagination.

Secondly, the posterior set of segments were not materially different in their form from those preceding them. In those cases where proglottides are shed singly, it is common for them to assume an oval form at the end of the body, and at least to be a good deal constricted at their junctions with each other. There is, commonly, also a very considerable increase of length of the individual proglottides, which favours an easy rupture of their connection. In none of these features do the terminal proglottides of this *Oochoristica* agree with those of the genera which constantly shed their proglottides singly. Indeed, I have observed that the five or six terminal proglottides are occasionally even shorter than those which immediately lie in front of them. These facts, coupled with the absence of a "neck" where new proglottides are formed, incline one to the belief that the growth of a scolex is limited, and that the whole posterior region dies and liberates the eggs. But of this I have no direct evidence. The relative

length and breadth of the proglottides differ in different regions of the body and in individuals. A small example (30 mm. in length) mounted in two pieces in Canada balsam showed the following characters of strobilisation. The diameter of the wider posterior region of the body was not more than three times that of the narrowest part of the neck. I made out in all 167 strobila, and there were not, I am convinced, many more. The first 42 were very short, being very much broader than long. After this point the diameter of the worm became greater, and the segments, therefore, larger; they appeared to be longer in proportion to their breadth; but the first 31 of the series were, I believe, not so. From this point, however, to the end of the body the length of the segments was proportionately a little greater. But throughout the series the actual breadth was really considerably greater than the length. In a second specimen, of which the head end only was mounted, the state of strobilisation presented quite a different appearance. The first 45 segments or so were quite as in the last specimen; but after this point the length grew very rapidly in proportion to the breadth, and in a few segments no measurements were needed to assist the eye in seeing that the proglottides were very much longer than broad. A careful examination of these elongated segments showed that the broader hind margin which overlapped the narrower anterior section of the ensuing segment was regularly crumpled, showing a series of regularly arranged projections, and in the middle of the segment these were represented by alternate furrows and elevations. This looks very much like the effect of a muscular pulling out of a segment from end to end. But in any case this variability in the proportions of individual proglottides shows that it is a difficult matter to define Tapeworms very accurately by the proportions of length and breadth of the proglottides in different regions. The instances given would appear to be those of proglottides which had been unduly lengthened through pulling longwise. But I have observed instances of the contrary. In some proglottides from the middle of the body there was a marked transverse wrinkling, a kind of division of the segment into annuli, which shows from a different point of view how difficult it is to rely upon the relative dimensions of proglottides as aids to the definition of a species or of a genus, as the case may be. It is certainly quite unsafe in the case of this *Oochoristica*.

Before proceeding to the consideration of the internal organs, there is one other external feature that requires description, namely, the *orifices of the generative ducts*. These are alternate, but not regularly so. The openings are, however, as a rule, preponderatingly upon one side of the body. Thus in a portion of one worm I found two pores consecutively upon one side of the body. The next was on the opposite side; the five following reverted to the first state, and the last examined showed again an alternation. In another specimen, from another worm, there was one pore on one side, followed by three consecutive pores on the

other side; then came two on the opposite side to these, and then two on the opposite side to the two last described. These instances will be sufficient to illustrate the general facts. It is quite possible that the proglottid which first shows these openings may vary from individual to individual. In any case a careful examination of a small individual mounted in two pieces upon a slide, and whose strobilisation has been already described above, showed no generative ducts in front of proglottid 113 or so. It will be remembered that this worm had a limited number of proglottides altogether, there being not many, if any, more than 167. In this particular case it was not difficult to ascertain accurately the point at which the ducts began. For, where present, they were extremely conspicuous through staining, and the cells composing the conjoined ducts formed a rather thick mass. And I am, therefore, sure that they did not exist, except perhaps in small rudiments, before the 113th proglottid. It was easy to ascertain that the gonads themselves—at any rate, the ovaries—existed anterior to this segment. Furthermore, these facts are still further supported by the condition of a second specimen which had been cut into longitudinal sections up to about the same point of the body. Here, too, the generative ducts did not exist much anteriorly to the 113th segment—if, indeed, at all anteriorly. The actual pores were only clearly visible upon more mature proglottides, and were quite conspicuous round orifices near to the anterior border of the proglottid.

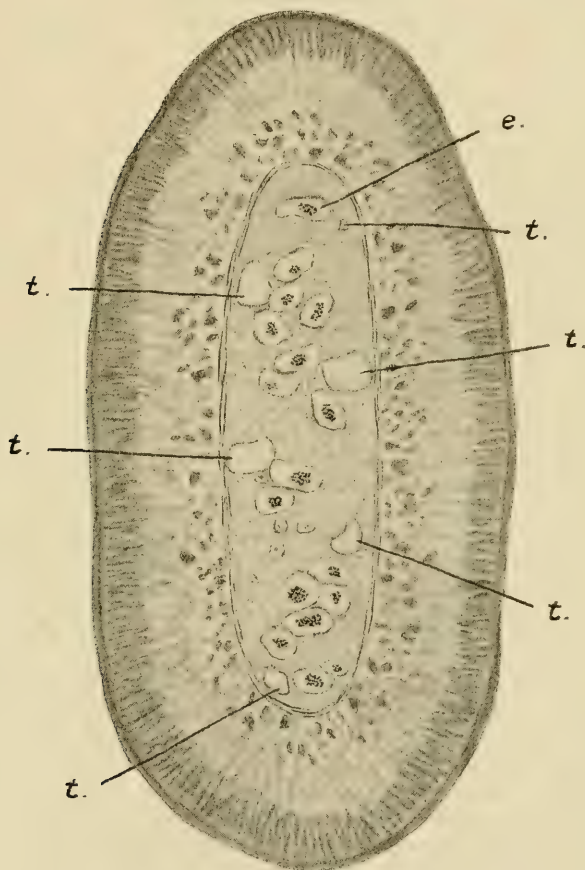
The excretory vessels would seem from the figures of Janicki to be very characteristic of the genus *Oochoristica*, for in the species figured by him there are additional lateral vessels varying according to the species. I have found the same thing in the species of *Oochoristica* which I describe in the present paper. The conditions, however, seem to vary somewhat in different regions of the body. Anteriorly there are eight, longitudinally running, which in the very anterior and therefore very thin segments are almost in the same plane, and therefore can be seen in a single longitudinal section. Further back the eight tubes are differently arranged. There are two nearer to the middle line and dorsal, according to Janicki*, and two ventral more widely separated. The two lateral tubes on each side are less markedly dorsal and ventral respectively. In posterior segments I could see only six longitudinal vessels, as is represented in text-figure 150, of which the four median were placed alternately with regard to each other, and not as in earlier segments.

The gonads are visible in sections rather early in the body. I found them without any trouble in the rather wider segments which follow immediately upon the anterior sixty or so segments which form the anterior section of the chain of proglottides. A somewhat leaf-shaped mass of cells, the apex directed posteriorly, and which represents presumably the yolk-gland as well as the

* *Loc cit.*

ovaries, reaches from near to the anterior boundary of the proglottid to beyond the middle of a segment. The *testes* occupy a restricted area in the posterior region of the segment, and I observed in these young proglottides something like 20 or 30 of them. They are not in contact with the ovaries, but, like them,

Text-fig. 150.



Transverse section of a posterior segment of *Oochoristica* sp., showing scattered embryos embedded in general parenchyma.

e. Embryo. *t.* Longitudinal trunks of water-vessels.

are median in position. I occasionally observed also 2 or 3 testes on one side of the ovary. Further back, when the genital ducts first appear, the testes still form a mass which is chiefly posterior

to the ovary, but which has also to some extent grown round the sides and lies laterally of the ovary.

Examining, as an entire object stained and preserved in balsam, some segments at about the same stage of development as those last referred to, it will be noticed that the small and numerous testes occupy in their extension from side to side of each proglottid about half of each proglottid. The lateral areas not invaded by the testes are together about equal in diameter to the middle region where the testes lie. The testes do not reach as far as the lateral excretory vessels, and naturally, therefore, not to the nerve-cord.

In the mature proglottides the generative organs have been studied by me chiefly by means of transverse sections. The ovaries may be said to be double and lie anteriorly; they occupy a good deal of the available space in the medullary region, and are by no means confined to the middle of the proglottid. The yolk-gland is single and lies behind the ovaries. The shell-gland lies medianly in the segment on the opposite side from the ovaries. I could find no receptaculum seminis, and the narrow vagina runs a straight course for some way before its external opening.

The testes in the mature segments occupy the posterior region of each proglottid; but they also extend forward on either side up to the level of the anterior border of the yolk-gland, and even a little beyond, so that in transverse section some ovarian tissue is occasionally seen in the same field with one or more testes. In transverse sections, the male gonads are seen to occupy pretty nearly the whole of the medullary layer of the worm, and are frequently in contact with each other. In segments of individuals which have apparently been stretched during life the testes were in a single row only dorsoventrally, or, at most, arranged here and there in the form of a "W," one testis being slightly dorsal of another. In such proglottides I never counted more than ten testes in a single row. On the other hand, in proglottides that were rather contracted than extended, the testes were frequently for a considerable extent of the proglottid in two rows, one above the other. In such cases as many as fourteen or even fifteen testes could be seen in one transverse section. The testes are of fair size, and in proglottides which are depressed occupy the whole of the medulla from above downwards. In the other case mentioned above, the medulla accommodated two testes one above the other, and not much room was left unoccupied by these bodies. In fully mature segments the testes are all of approximately the same size, and there must be some fifty or so in a single proglottid. It is easy to trace a thin membrane surrounding each testis, and completely shutting it off from the parenchymatous tissue of the medulla from neighbouring testes. This is the state of affairs that we find in fully mature segments, in which, however, there is as yet no scattering of the eggs in the parenchyma, such as occurs in the terminal segments of the body. In a young specimen mounted entire, the testes were quite plain in certain anterior segments of

the body, wherein the genital ducts had not attained their full development. In such a segment the testes are seen to be distinctly more numerous than in such segments as have just been described, a transverse section would show fully twenty testes in a given plane (in the region of the proglottid where they are most abundant). At the same time, these gonads are much smaller. I have sections of proglottides which show an intermediate state of affairs, and in which the posterior testes are large and apparently full-grown, while anteriorly the testes are very small and quite similar to those of immature or only incompletely mature segments. These immature testes had no membrane that I could detect. It appears to me that the advance in growth of these gonads is achieved by the inclusion within a common membrane of areas of testicular growth which have separately originated and which in the very youngest stages can be seen to consist of a single cell only. It will be observed that the disposition of the testes of this species is quite like that of some other forms belonging to this genus as described by Janicki*.

Several fortunate sections have enabled me to see very clearly the arrangement of the *vas deferens* and its mode of termination. This tube is loosely coiled not far from its entry into the cirrus sac. Before it enters the latter it passes in a straight course and enters at the very extremity of the sac. It is noteworthy that this duct is quite double the width of the vagina at its opening into the genital cloaca and for some distance behind this point. The *vas deferens* when it enters the cirrus sac at once swells out into a small *vesicula seminalis*, which thus lies within the cirrus sac instead of outside as in most cases. The *vesicula* does not by any means fill even the end of the cirrus sac in which it lies. Immediately after this the duct narrows again, and again immediately swells out into a smaller dilatation. After this comes the narrow cirrus itself. The walls of the cirrus sac are loose and muscular.

Lühe, the founder of this genus, in some notes† upon the anatomy of species of *Oochoristica* from Lizards (for example, *Tænia tuberculata* of Rudolphi), remarks that the development of the uterus must be extraordinarily rapid, as so often no intermediate stages are obvious between a fully developed ovary and the scattering of the mature eggs in the parenchyma. I quite agree with Lühe, for the reason that the uterus is not always to be found and is at least by no means so characteristic of this particular Tapeworm as it is of many others. There are, however, stages to be observed. I have never seen more than a small elongated sac lying near to either the ventral or the dorsal side of the segment. In longitudinal sections this sac shows a tubular form, and is, indeed, so narrow a tube that on first observing it I mistook it for one of the excretory vessels, and imagined that the

* Zeitschr. f. wiss. Zool. lxxxi. 1906.

† "*Oochoristica* nov. gen. *Tæniadurum*," Zool. Anz. xxi. 1893, p. 650.

gonads were passed to the exterior through those tubes. However, the uterus is actually present in this form.

From the above account of the external characters and internal anatomy of this worm we may deduce the following brief résumé:—

Length 30–60 mm., diameter 1 mm.–2 mm. Posterior region of the body markedly differentiated in fully adult examples by its great thickness, but anterior end not so thin as in many forms. Terminal segment with deep slit-like depression always present. Scolex unarmed with rudimentary rostellum. Suckers unarmed and sunk within the head, which is tetragonal in section. No neck, segmentation beginning at once; the anterior five or six proglottides wider than scolex and seeming to form a hood into which it can be partly retracted. Proglottides variable in proportions of length to breadth. In many examples all of them, save the last few, broader than long. In others some of anterior segments longer than broad. Dorsal and ventral excretory canals not parallel, the two dorsal being nearer together than the two ventral; in addition to these, two lateral narrower canals on each side. Cortical layer as thick as medullary. Genital pores alternate irregularly, the preponderance being on one side, near to anterior border of proglottid. Testes numerous, posterior to and at the sides of ovary. Ovaries in anterior part of proglottid commencing shortly after anterior border. Genital ducts pass between dorsal and ventral water tubes. Vas deferens coiled; no obvious seminal receptacle or seminal vesicle. Uterus sac-like, with branches; ultimately disappearing, the eggs being imbedded singly in the parenchyma. Occasionally traces of uterus in form of sacs containing two or three ova persist.

Hab. Small intestine of *Tamandua tetradactyla*.

We may now consider the systematic position of this Cestoid. The lateral position of the genital pores, the unarmed scolex, the four suckers without appendages or hooks, the anterior position of the cirrus pouch, the absence of more than a suggestion of a pseudoscolex, show that this worm is to be referred to one of the three families Anoplocephalidæ, Hymenolepididæ, or Tæniadæ, of Ransom's systematic table* (which is with slight differences the same as that of Fuhrmann†). From many of the numerous genera contained in the first two of these families and the very few genera of the last, the present worm is to be differentiated by the following assemblage of characters:—scolex unarmed, no neck; genital organs one set to each proglottid, with irregular pores; testes numerous, posterior in position; uterus disappears; eggs imbedded singly in parenchyma.

The characters of the worm rather suggest the Anoplocephalidæ, particularly, of course, the unarmed scolex and the absence of a "neck." But there is no genus in this family to which it can be referred. The nearest is *Linstowia*, in which the genital pores are alternate, the eggs are imbedded singly, and the cortical layer

* Bull. U.S. Nat. Mus. no. 69, 1910.

† Zool. Jahrb. extra vol. x, 1908.

of the body is thick. But in *Linstowia* the testes extend throughout the proglottid, the genital ducts pass ventrad of the excretory vessels, and there are other differences. Of the Hymenolepidæ the following genera only have an unarmed scolex and a single set of generative organs with alternate pores, viz., *Catenotenia*, *Oochoristica*, *Rhabdometra*, *Anonchotenia*, *Metroliaesthes*, and *Nematotenia*. *Nematotenia* may be set aside as only showing strobilisation posteriorly. In *Anonchotenia* the testes are anterior and the eggs finally pass into a paruterine organ. In *Rhabdometra* and *Metroliaesthes* the testes are posterior and at the sides of the ovary, and the genital canals pass between the excretory vessels as in the species which forms the subject of the present communication; but in those genera, as in *Anonchotenia*, there is a paruterine organ into which the eggs finally pass. There remain, therefore, by this process of exclusion only *Catenotenia* and *Oochoristica*. The former genus must be eliminated, since the genital ducts pass dorsad of both excretory tubes* and the uterus is persistent. The present species is therefore to be referred to a new genus or is to be included in *Oochoristica*. More recent information about this latter genus than was available to Ransom when he drew up his table shows—what is, indeed, also apparent from that table—that the worm with which I have occupied myself is an *Oochoristica* and does not need a new genus for its reception. Ransom's definition is: "Scolex unarmed, without rostellum. Single set of reproductive organs in each segment. Genital pores irregularly alternate. Testicles numerous, surrounding female glands posteriorly and on the sides. Vas deferens coiled; seminal vesicle absent. Uterus breaks down early and eggs become enclosed singly in egg capsules." I shall now deal with the question of the species to which these worms should be referred.

So far as I am aware, only two Tapeworms have been described from the gut of *Tamandua tetradactyla*. The first of these is *Tenia tetragonocephala* of Bremser, described by Diesing †, and later, as well as more fully, by Lühe ‡, whose description disagrees in several particulars with that of Diesing. The most important external disagreement concerns the scolex, which is represented by Diesing as having no neck, while Lühe finds a neck 2 mm. long. This is obviously a matter of some importance; and I am inclined therefore to regard the Tapeworm described here by myself as not identical with *T. tetragonocephala* for that reason alone. With the general anatomical description added by Lühe to Diesing's account the worms studied by myself fully agree, and are clearly of the same genus which Janicki § more recently has shown to be *Oochoristica*. Janicki's memoir contains also additional facts

* This point is not referred to by Ransom in his definition of *Oochoristica*; I have not accidentally omitted it.

† Denkschr. k. Akad. Wien, xii. 1856.

‡ Arch. f. Naturg. 1895, p. 199.

§ Zeitschr. f. wiss. Zool. lxxxi. 1906, p. 524. See also Zschokke, "Das genus *Oochoristica*," *ib.* vol. lxxxiii.

upon the anatomy of *O. tetragonocephala*, which confirm my opinion that the species examined by myself is not the same. In particular, I refer to the much more complicated excretory vessels, which are illustrated by a text-figure*.

The second species inhabiting the gut of *Tamandua tetradactyla* is *Oochoristica wagneri* of Janicki, who had, however, only a single not very well-preserved example to work upon. Unfortunately one very important point, as I think it, viz., the condition of the neck, was not ascertained, and, as I understand, could not be ascertained by Janicki from the imperfection of his specimen. There are some other points in which my specimens were not identical with that described by Janicki. He described ripe proglottides as longer than unripe ones. But this is not always the case in my specimens, since I have found quite early in the strobila long segments. But the examination of other examples might have led Janicki to alter this statement. For, as I have myself shown, there is some variation in the form of the proglottides in different regions of the body and in different examples. I have noted in describing the excretory tubes certain differences from the apparently regularly arranged six tubes found in *O. wagneri*; but here, again, it is possible that the examination of more material would have shown that these differences do not exist.

On the other hand, I am disposed to see differences in the uterus in the two forms. Janicki describes that organ in *O. wagneri* as an irregular sac lying anteriorly in the segment and extending back as far as or beyond the ovaries, and gives a figure showing this arrangement. The uterus in my examples was much more irregular, and here and there, as I have described, were quite tubular portions of it.

Even in the very last segment of the body, which might be supposed to be fully mature, the uterus had by no means quite disappeared in all specimens, although the majority of the eggs were strewn through the parenchyma, as Janicki states to be the case in his species, and as is characteristic of the genus. In other respects I can find no differences between the facts as I read them and Janicki's descriptions. I do not, therefore, from a consideration of all the facts, come to the conclusion that the present species is certainly distinct from *O. wagneri*, but that equally it is not certainly identical with it. Since we know that two undoubtedly different species are found in the Edentate *Tamandua*, there is no *à priori* reason against the existence therein of a third or even of more species of this genus. I prefer, therefore, in view of these doubts, to give no name to the worm which is here described.

Bertiella cercopitheci, sp. n.

An example of the Green Cercopitheque, *Cercopithecus callitrichus*, which died in the Society's Gardens in February 1911, contained two examples of a Tapeworm, which were found,

* *Loc. cit.* p. 535, fig. 5.

contrary to what is more usual, in the colon and not attached to the walls of that gut. It may be, therefore, that the parasites had been loosened from their attachment in the small intestine and had drifted into the colon, of which portion of the alimentary tract they are therefore not really inhabitants. However, both specimens were quite alive and exhibited writhing movements, and it is possible therefore that they are really parasitic in the colon. They were of about the same size, and shrunk considerably on preservation in alcohol. One of the two specimens, which I have preserved entire and regard as the type of the species, measures in the alcoholic condition 150 mm. It is remarkable for the extreme shortness and great width of the segments, and agrees in this particular with species of the genus *Bertiella*, of which other anatomical characters prove it to be a member.

The anterior extremity (as is shown in text-figure 151) is very minute, and the body gradually widens up to a diameter of some 10 mm. Its general appearance is thus not precisely, although it is generally, like that of other species of this genus. Accompanying the increase in width of the proglottides there is also an increase in thickness, and the posterior end of the body is about 2-3 mm. thick. In addition to the two specimens of the worm there was a detached piece, possibly of one of these, of about an inch in length. It appears to me that, as in *Bothriocephalus*, for example, the proglottides are not shed singly but in groups. The head of the worm is black in parts, the arrangement of the pigment being peculiar, as I shall describe shortly. This black-headed condition suggested to me that we might be dealing here with examples of P. van Beneden's *Tænia melanocephala**, a parasite from another species of African Monkey. The other characters given by van Beneden are in perfect harmony with this view of the identity of the species, but, as Blanchard† has pointed out, the characters given are really not enough to determine the genus to which *Tænia melanocephala* belongs, let alone the species.

Nor does my discovery here recorded of a black-headed Tape-worm found in an African Monkey, and clearly referable to the genus *Bertiella*, in any way settle the point at issue. For, in the first place, I have found in a species of *Davainea* (or, at any rate, an allied genus) the same distribution of the pigment in the head that will shortly be described in the species now under consideration; so that the mere presence of pigment in the head is clearly no criterion of the identity of the worm. In the second place, another species of *Bertiella*, viz. *B. mucronata*, also from a monkey, has been described‡ in which the head is likewise pigmented. It will be shown later that my species is not *Bertiella mucronata*. Moreover, there is no reason, owing to the defective description of van Beneden, for the identification of *B. melanocephala* with *B. mucronata*. Thus it is necessary, as I think, to give a new name

* Mém. sur les Vers intestinaux, Paris, 1859, p. 162.

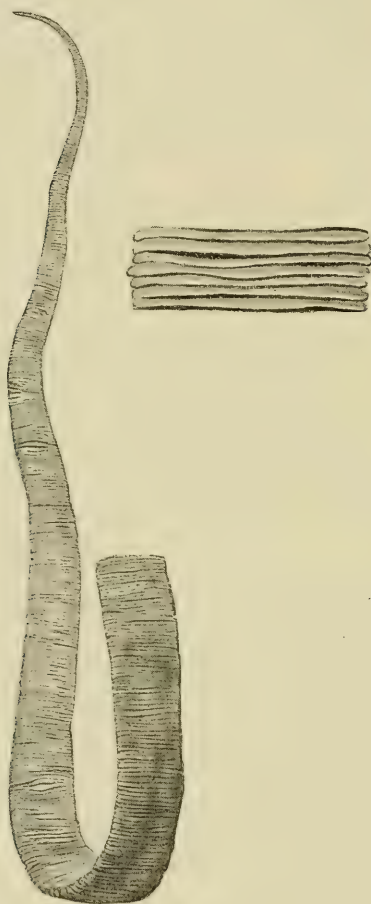
† Mém. Soc. Zool. France, 1891, p. 186.

‡ Meyner, "Zwei neue Tænien aus Affen," Zeitschr. f. Naturw. 1895, p. 1.

to the present species, in spite of the fact that it may prove ultimately to be identical with *Bertiella melanocephala*.

In any case, I shall be adding some further facts to the general anatomy of the genus by the following account of this form.

Text-fig. 151.



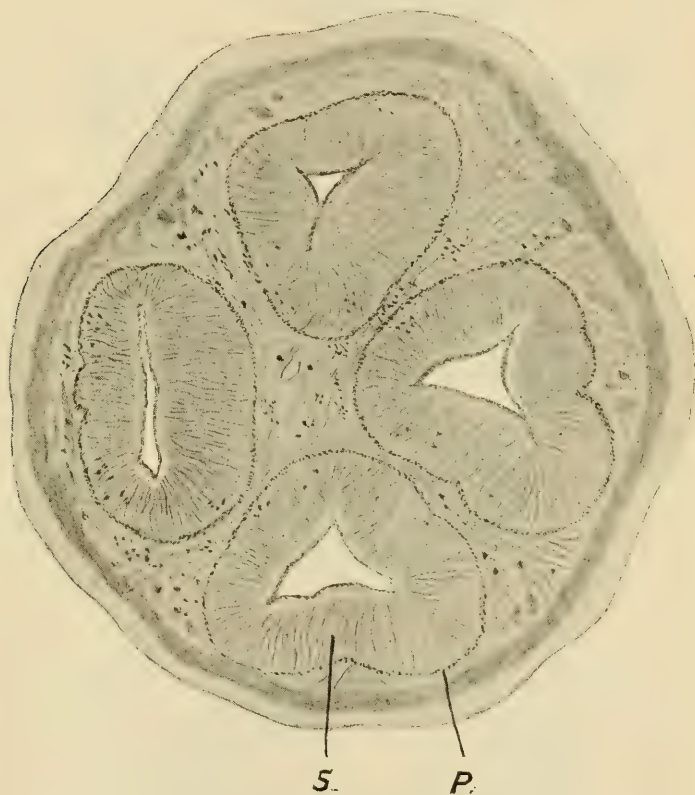
Bertiella cercopitheci, nat. size.

A few of the posterior segments are shown more highly magnified.

The *head* is rather narrower than the ensuing body, in which the proglottides are evident from the very first, there being thus no neck. In the two specimens which I have examined, the suckers presented different conditions. In one they were apparently

absent altogether, being really retracted almost completely within the head; there were four little tags only protruding from the anterior extremity. This scolex I have examined further by transverse sections. The second worm showed only two cup-like suckers, with their cavity directed upward as in other species of *Bertiella*. One of these is distinctly larger than the other, and

Text-fig. 152.



Bertiella cercopitheci.

Transverse section through scolex.

S. Sucker. P. Pigment-sheath of the same.

I presume that the remaining two were completely retracted within the head. In a series of very nearly accurately transverse sections through the head of the first individual, the earliest sections showed four equidistant grooves lined by a continuation of the thick cuticle of the scolex, which expanded towards the

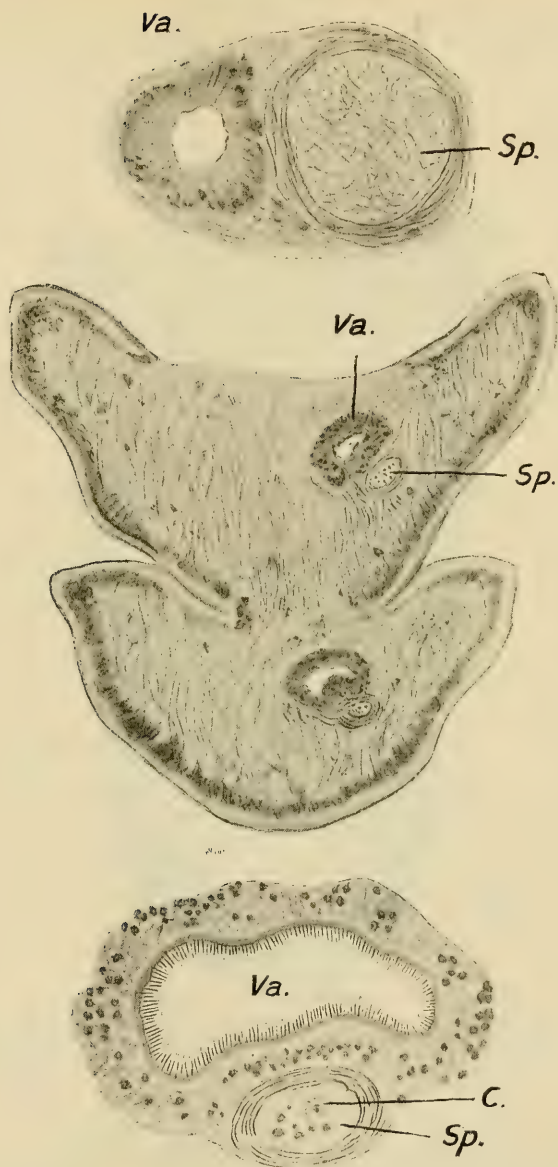
middle of the interior of the scolex into oval chambers lined by an equally thick cuticle. Further down the canals lost their connection with the exterior and were T-shaped, with still a very thick cuticular lining and no recognisable sucker structure. This canal in each of the four quarters of the scolex continued for some sections without any change, and then the suckers themselves became plainly visible, being thus entirely retracted within the scolex and removed from the exterior. The cavity of the suckers is here triangular, with the sides closely pressed together. The outlines of each sucker are sharply marked off from the surrounding tissue of the scolex by a layer of black pigment granules, which pigment is also found in the central portion of the scolex. The lining cuticle of the suckers is much thinner than that which covers the scolex, and lines the canal of invagination leading to the suckers. The outline of the scolex is here approximately circular.

The *generative organs* are visible in an immature condition very early in the body, though I have not made an accurate determination of the exact segment in which they first occur. At first I could find no trace of any testes, simply a mass of generative blastema which occupies the position of the future ovaries, vitelline gland, and shell-gland, from which leads a solid rod hardly narrower towards but not to the edge of the proglottid; this latter is, of course, the vagina, &c. This mass of tissue lies just anterior to the transverse vessel, uniting the two ventral excretory vessels, and is therefore some way from the posterior boundary of the proglottid. In transverse sections through these very anterior and immature proglottides it is seen to lie upon the ventral side of the transverse vessels and to cross it obliquely to the dorsal side, whence it passes towards the edge of the proglottid to the dorsal side of both dorsal excretory tube and nerve. This is the same on both sides of the body, the generative organs being single and alternate in this worm.

Only a segment or two further back than those just described the testes become visible, though, of course, at first quite immature. They form a row generally only one deep (when viewed in longitudinal horizontal section) extending from the excretory tubes of one side of the body to those of the other. I counted about fifty small testes in such a row. Here and there the row is two deep. I could detect no trace of the vas deferens. The row of testes was anterior to the rudimentary female organs. These latter are by this time somewhat more developed. They still present, however, a perfectly straight line, but reach very nearly to the edge of the proglottid. There is, however, no external aperture. The fact that the vagina is a tubular formation is beginning to be evident, and the shell-gland, with radiating cells, in which it ends is plain; the ovary and vitelline gland lie below it and thus not in the same plane with the vagina.

The female organs extend over more than a quarter, but not quite a third, of the diameter of the proglottid. In still later proglottides the uterus is for the first time quite visible and can

Text-fig. 153.

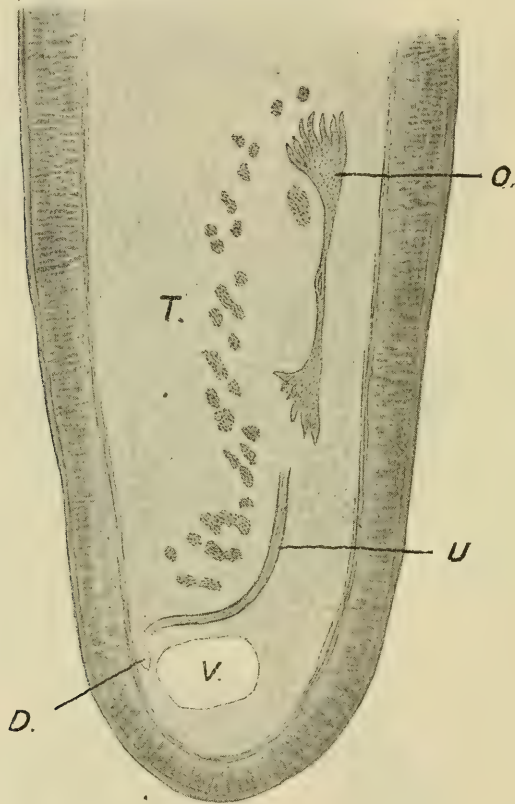
*Bertiella cercopitheci.*

Sections through sperm-duct and vagina at three points near to their external orifices, to illustrate relative position and structure.

C. Cirrus. Sp. Sperm-duct. Va. Vagina.

be traced for a considerable distance either way as a solid cord of cells of a fibrous appearance, being more darkly stained than the surrounding parenchyma. I could detect no lumen in this young uterus. It runs straight along the ventral side of the row of testes; arrived near to the lateral vessels, it bends at right angles

Text-fig. 154.

Transverse section through immature segment of *Bertiella cercopitheci*.

D. Dorsal water-vessel. *O.* Ovary. *T.* Testes. *U.* Uterus.
V. Ventral water-vessel.

and runs straight dorsally to the inside of, and close to, the water-vessels, crossing the vagina at right angles on its way. I could not ascertain definitely the opening of the sperm-duct into the cirrus sac which lay parallel with and dorsally to the vagina. Nor could I see any branches running from the sperm-duct to the

individual testes at any point. It is for this reason that I regard the cord of cells as the beginning of the uterus and not as a spermduct, which it undoubtedly suggests in its appearance and position.

In mature segments, when both the vas deferens and the receptaculum seminis contain sperm, but when the uterus is still of moderate dimensions only, the *testes* are seen to extend right across the body, when there is room for them, up to the lateral excretory vessels on either side. In transverse sections they are seen to be not more than two or possibly three deep in the middle region of the proglottides. They are rather more dorsal than ventral in position and are above the uterus. In the lateral regions of the segments they are more crowded and often rather closely pressed together. I could not find that the testes existed outside of the medullary region of the segments, a point which I mention particularly, since Meyner* met with testes (in *B. conferta*) which had traversed gaps in the transverse musculature and had taken up their position among the longitudinal muscles.

The *ovaries* in the young proglottides are quite distinct and even some way apart from each other, being joined by a thin bridge which is the oviduct and which dilates in the middle into a round sac marking the point of junction of the two oviducts. Even in young stages the ovaries are divided into numerous digitiform processes, which are not in the young stages thicker at their free extremities. These processes radiate out from a common centre, fanning out away from each ovary respectively. The ovaries are ventral in position and radiate out towards the dorsal side of the segment. In mature proglottides the ovaries are apparently nearer together, that is, the connecting bridge is thicker and forms a continuous junction of germinal tissue between them. The processes of the ovary are now club-shaped, *i. e.* thicker at their free ends. Their arrangement is otherwise the same, but they are much more numerous. In such proglottides the two ovaries together occupy about one-quarter of the breadth of the body. They are massed towards the pore side of the proglottid. The double character thus remains distinct and is more marked than is figured by Meyner for his species *Bertiella mucronata* and *B. conferta*.

The *vitelline glands* also exhibit a double character and are to some extent a copy of the ovaries in their general form and relations to each other. Each gland in the mature proglottides lies a little above and between the ovaries. The dorsal position of the vitelline glands with regard to the ovaries is shown by the fact that the latter, when fully developed, extend dorsally at their lateral margins and thus come to encircle the vitelline glands lying between them. Each vitelline gland is lobate, with numerous oval lobes tending towards a club shape radiating out from a

* *Loc. cit.* p. 93.

common centre, there being thus a likeness to the ovaries. The two glands are likewise united by a bridge of tissue. Both the ovaries and the vitelline glands are in close contact with the walls of the receptaculum seminis. The shell-gland lies again rather dorsally to the vitelline glands; but here the growth of those glands laterally causes the shell-gland to lie rather between than above the vitelline glands. It is in close relation with the median end of the receptaculum seminis, which does not extend beyond it.

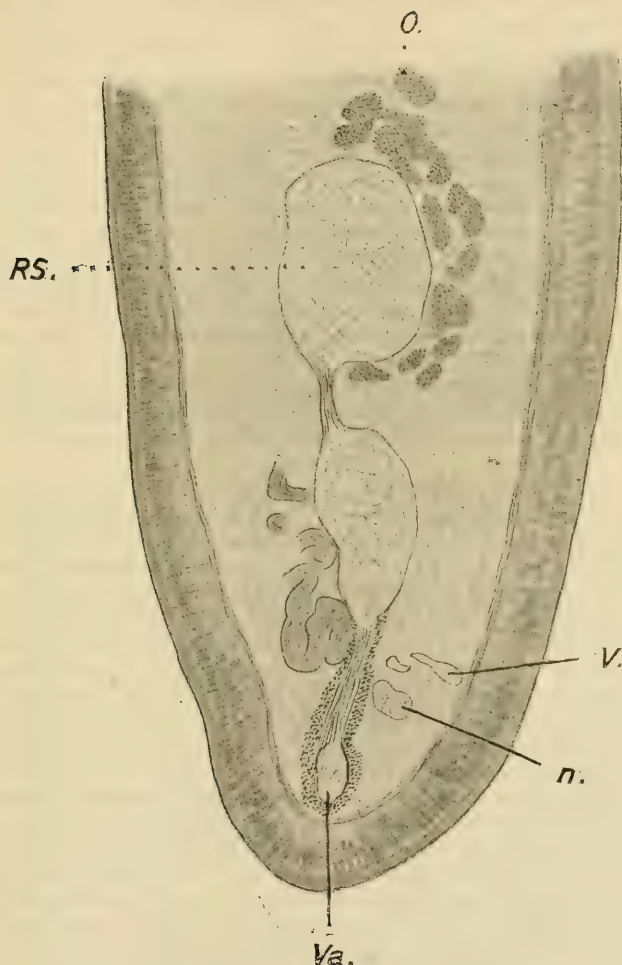
The *sperm-duct* in the mature proglottides has a form apparently like that of other species of *Bertiella* parasitic in Monkeys, and is not to be distinguished, so far as I can see, from that of *Bertiella mucronata*. The sperm-duct is of considerable width from the very first, *i. e.* where it emerges from the cirrus sac. It is probable, however, that this region is really to be looked upon as representing the vesicula seminalis of other Cestodes. A part of this dilated sperm-duct lies actually within the cirrus sac as is depicted for *Bertiella polyorchis* by v. Linstow. This portion, which is quite short, is wider than the section which follows. The latter, however, is also wide and lies in pretty regular coils of three alongside the vagina as far as the commencement of the wide receptaculum seminis. It is gorged with sperm and its walls are thin, but very plainly recognisable by their dark staining. The coiling commences directly after the emergence of the sperm-duct from the cirrus sac, and we have therefore here a coiled region of the sperm-duct which corresponds to that characteristic of many other Tapeworms, but with the addition that it is the vesicula seminalis part of the sperm-duct which is coiled.

The sperm-duct appears to come to abrupt conclusion at about the commencement of the wide receptaculum seminis. But in favourable sections it may be traced further as a very slender tube closely adherent to the ventral wall of the receptaculum. In the posterior segments of the body, which are distended with ova, the sperm-ducts do not degenerate; on the contrary, they are somewhat larger than in the first mature segment. They contain, moreover, more sperm, which has somewhat distended them: the walls thus appear thinner. The ducts in this region of the body lie quite as coiled as in the more anterior proglottides; it might be supposed that they would be straightened out by the tension caused by the enclosed spermatozoa. Nor has the sperm-duct in any way shifted from the normal position, lying, as it does, alongside of, and in close contact with, the vagina, which has undergone in this region of the body considerably greater alterations. The same triple arrangement of the coils is visible—that is to say, in a given transverse section there are usually three tubes to be seen, this being, of course, the expression of the coiling.

The *vagina* of this species is specialised into several regions, as it is shown to be in *B. mucronata* and *B. conferta* in the figures of Meyner. The proglottides, from an examination of which I have compiled the following description, appear to be in much the same stage of sexual development as those figured by

Dr. Meyner*, for which reason, of course, I have selected them. The terminal region nearest the external pore has a thick muscular sheath and the lumen is narrow. This section widens abruptly

Text-fig. 155.



Transverse section through mature segment of *Bertiella cercopithecii*.

n. Nerve-cord (only one of the three strands visible). *O.* Ovary. *RS.* Receptaculum seminis. *V.* Ventral water-vessel. *Va.* Vagina, to the left of which is seen the dilated and coiled sperm-duct.

* *Loc. cit.* pl. i. fig. 3, pl. ii. fig. 9.

into a thin-walled and much wider section, the muscular walls of which are not more than, if so much as, half of the diameter of those of the previous section. The transition is not regular, as is figured by Meyner in the two species examined by him. The diminution in thickness of the muscular layer, however, is rather gradual at the orifice of the terminal part of the vagina into the middle region.

This middle region of the vagina contained sperm in the mature segments. It apparently ends abruptly on the median side, but is really connected by a very narrow tube, not wider than the sperm-duct, with the distal section of the vagina, which may be termed the receptaculum seminis. This section is twice the width of the last, and into it opens the duct from the ovaries &c., which is about as wide as the intermediate passage connecting the receptaculum and the vagina. The receptaculum seminis thus begins and ends abruptly. It contains sperm, as does the distal section of the vagina. At the orifice into the genital cloaca the sperm-duct and the vagina lie obliquely with reference to each other. The sperm-duct is anterior, but also dorsal to the vagina, and a little further back is completely dorsal to it. In the very posterior segments, which are otherwise filled with the distended uterus, the vagina with its receptaculum seminis shows an alteration. It has increased in size, owing to its being gorged with sperm.

I presume, at any rate, that the granular, in places fibrous-looking, contents of the vagina are sperm, though they have a different appearance from, and stain differently to, the obvious spermatozoa which fill the neighbouring vesicula seminalis. In the posterior proglottides the vagina shows no differentiation into regions such as have just been described, excepting the proximal muscular region near to the external pore. The rest forms a wide uniform tube, and in longitudinal horizontal sections is seen to be as wide as the proglottid is long or nearly so. In exceptional cases even this amount of differentiation in the vagina is lost and the wide tube pushes itself as far as the external pore, crushing the cirrus sac into a mere rudiment.

From the above detailed description of this Tapeworm there may be abstracted the following *résumé* of its characters:—

Length of about 150 mm., greatest breadth 10 mm. Shape an elongated cone, gradually diminishing to scolex. No neck, the strobilisation commencing immediately after scolex. Proglottides very short and wide, not increasing posteriorly in length. Scolex with four suckers looking upwards, completely retractile into head, with black pigment. No armed rostellum. Dorsal and ventral excretory tubes at first subequal, later the ventral very much the larger; the two tubes are superposed dorso-ventrally, with a transverse trunk connecting the two ventrals. Genital pores alternate, frequently with regularity. Generative ducts dorsal to water-vessels and nerve. Testes numerous, forming a layer two or three thick, reaching completely between water-vessels, anterior and dorsal in position. Cirrus feeble, no sperm-sac (vesicula seminalis). Sperm-ducts

open to side and in front of vagina and pass back along ventral margin of rows of testes. In fully mature segments sperm-ducts increase in volume. Ovaries double, ventral and posterior in position, in front of transverse excretory vessel, formed of numerous club-shaped masses radiating from common centre. Vagina unusually wide, showing a marked receptaculum seminis in less fully mature proglottides; the width increases enormously in the fully mature proglottides until it is nearly as wide as the proglottid is long. Genital cloaca short. Uterus single, sac-like, without definite outgrowths, but somewhat irregular in form, filling most of the proglottid. The eggs without V-shaped apparatus, with a thinner inner shell and a very wide and lax outer membrane. Proglottides apparently not detached singly, but in groups.

Hab. Cercopithecus callitrichus.

It is clear from this definition that the Tapeworm now under consideration has been rightly referred by me to the genus *Bertiella*. There is, I think, no other genus which shows the same assemblage of characters as those which I have just set forth in brief. It remains to be seen what position the species occupies within the genus, of which we now know a good many different species.

It seems that we may select the following characters as distinctive of this species, which will be thus definable:—

BERTIELLA CERCOPITHECI, sp. n.

Length 150 mm. or more, breadth 10 mm. posteriorly, gradually tapering to head. Scolex with black pigment scattered throughout middle of scolex and forming a special layer round each sucker. Suckers directed anteriorly, and completely retractile. No neck, strobilisation commencing at once. Lateral nerve-cord divided into three, the middle one the largest. Lateral water-vessels superposed, the dorsal much the smaller. Testes extending between water-vessels, forming a layer two or three deep and three or four wide in middle region of proglottid, more numerous laterally. Vesicula seminalis very long and coiled, extending into cirrus sac. Vagina divisible into two well-marked regions and communicating by very narrow interval with wide receptaculum seminis. Eggs without pyriform apparatus.

Hab. Cercopithecus callitrichus, in colon (?).

Following the subdivision of the species of *Bertiella* by Zschokke* into three groups, the present species evidently belongs to the first group, to which Zschokke assigned *Tænia mucronata* and *T. conferta* of Meyner†. *Bertia studei* and *B. satyri* of Blanchard‡ are doubtfully admitted by Braun§ into the genus *Bertiella* as recognised by the better-known species fully described by Meyner, for Blanchard does not describe the genital

* "Neue Studien an Cestoden aplacentaler Säugethiere," Zeitschr. wiss. Zool. lxx. 1897, p. 404.

† "Zwei neue Tænen aus Affen," Zeitschr. f. Naturw. 1895, p. 1.

‡ Mém. Soc. Zool. France, 1891, p. 186.

§ Broun's Klassen u. Ordn. des Thierreich, iv. Abth. 1 B, p. 1712.

organs, except in so far as to remark upon their alternating pores and upon the structure of the ova. Nor does he say anything of the pigmentation of the head, which is so marked a feature of my species and of the otherwise unrecognisable *Tenia melanocephala* of van Beneden*.

B. mucronata was described from an American Ape, *Mycetes niger*, and I gather from Meyner's description that the Tapeworms themselves were brought from Paraguay, and thus real inhabitants of the Monkey in question, which, therefore, had not been infected in a menagerie. This species shows the same pigmentation of the head as mine, and its general shape† is not very different. Nevertheless, it appears to me that in the species described in the present paper the anterior end is more tapering, and has a very small diameter for a longer stretch. Indeed, the general outline of the worm described in the present paper is more like Meyner's *B. conferta*‡, which is, moreover, a parasite of an Old World Monkey, *Macacus radiatus*, and therefore, perhaps, more likely on *à priori* grounds to be identical with mine. I think, however, that *B. conferta* may be put out of court in this comparison, for the reason that no mention is made of a black pigmentation in the scolex, which is so clear a feature of my species and of *B. mucronata*. Nevertheless, *B. conferta* agrees with my species and differs from *B. mucronata* in that the vagina enters the receptaculum suddenly, there being no gradual widening as in *B. mucronata*, where the tubes are continuous. The suckers are said, however, to be lateral in position, as in *B. mucronata* §. This is one of the principal reasons which lead me to regard my species as distinct. Of *B. mucronata* Meyner writes:—"Sind nicht vollständig nach vorn, sondern mehr zur Seite gerechtet." In a series of transverse sections through *B. cercopitheci*, which I have described above, it is very clear that the apertures of the suckers are not lateral nor slit along the retracted sucker, such as is so obvious in the other species described in the present paper.

Nor does Meyner describe the remarkable pigment-sheath to each sucker which characterises my species. Furthermore, it appears that *B. mucronata* has a "neck": for Meyner writes ||:—"Schon etwa 0.9 mm. vom Skolexscheitel entfernt, also in einem Stadium, wo der Körper noch keine Spur einer Gliederung erkennen lässt, gruppieren sich," etc. Stiles, in reviewing ¶ the characteristics of this species, points out that *B. mucronata* is also to be defined by the fact that the generative canal passes to the exterior *between* the nerve-cord on the one hand and the two excretory vessels on the other. My sections of *B. cercopitheci* show very plainly that the generative canal passes dorsally to *both* nerve and lateral excretory vessels. This is particularly

* Mém. sur les Vers intestinaux, Paris, 1859.

† *Loc. cit.* pl. i. fig. 1.

‡ *Loc. cit.* pl. ii. fig. 8.

§ In other *Bertiella* (e.g. in Sluiter's *B. plastica*, see Centralbl. Bakt. xix. 1896, p. 941) the suckers look upwards.

|| *Loc. cit.* p. 81.

¶ *Proc. U.S. Nat. Mus.* 1896, p. 145.

obvious in young proglottides, which are so slender that the disposition of these structures can be seen in a single section.

A final point of systematic importance concerns the horn-like processes of the innermost egg-shell, which are figured by Meyner and stated by him to be always very obvious. I have been absolutely unable to detect these structures, even when using an oil immersion-lens ($\frac{1}{12}$ in. Leitz). We must, therefore, agree that this group of species of *Bertiella* is to be characterised, as the two remaining groups into which Zschokke divides the genus, by "birnförmiger Apparat nicht constant." I am unable to compare the species which I describe here as *Bertiella cercopithecii* with two species described by Gottheil* from *Macacus cynomolgus* and from that species and *Cebus capucinus*, since they are not sufficiently diagnosed, and Stiles is of opinion that they are only doubtfully to be referred to the genus *Bertiella*. Indeed, the position of the genital pores is not referred to.

Another Monkey parasite with which my Tapeworm might be compared is v. Linstow's *Bertiella polyorchis*† from *Macacus cynomolgus*. This is interesting, from the point of view of the egg-shells, and confirms what I have said above concerning the absence of the horn-like processes in *B. cercopithecii*; for it is hardly likely that so experienced a helminthologist as Dr. von Linstow would have overlooked these structures were they present, and his figure of the egg of *B. polyorchis* does not show them. Furthermore, the suckers look forward and a dilation of the sperm-duct within the cirrus sac is figured. The species, however, differs, as I believe, from *Bertiella cercopithecii* by its less complicated vagina, by the much greater number of testes which fill the middle of the proglottid, and by the absence of any black pigmentation in the head. At any rate, the latter point is not referred to.

***Thysanosoma gambianum*, sp. n.**

I obtained from an example of the Gambian Pouched Rat, *Cricetomys gambianus*, which died in June 1909, a considerable number of Tapeworms which I regard as being of a new species and belonging most probably to the family Anoplocephalidæ. The Rodent had been one year and ten months in the Society's Gardens before its death, and it is, therefore, quite credible that it was infected with these Cestodes when it arrived in London. The material, as well as being abundant, was well preserved, and I am therefore able to give a fairly comprehensive account of the anatomy of the species, which presents certain new combinations of characters.

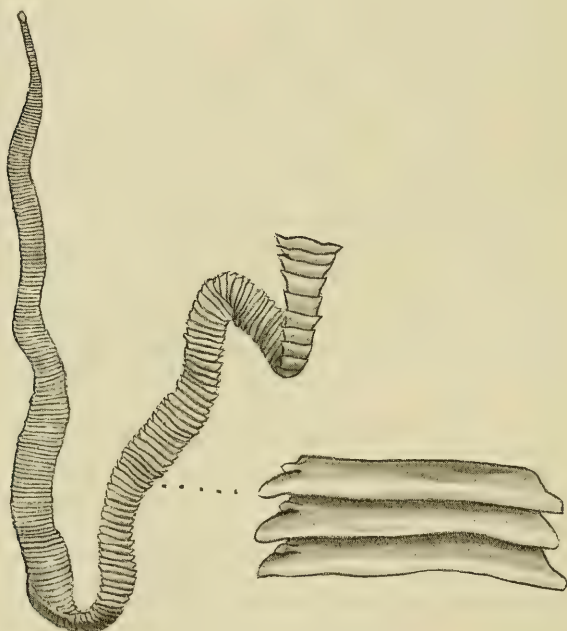
The external characters alone appear to place this worm in either the genus *Anoplocephala* or *Zschokkeella*. There are no other genera in which the scolex is unarmed, the genital pores are unilateral and the neck is absent, and the segments until the

* Journ. Comp. Med. & Surgery, 1887, vol. vii. The species are not named and are referred to *Tænia*.

† Arch. f. Naturg. lxxi, 1905, p. 270.

very end of the body are broader than long. Unilateral genital pores occur only in these two genera among the subfamily or family Anoplocephalidæ or Anoplocephalinæ. There are, however, several genera among the remaining Tetracotylea which possess genital pores in sequence upon one side only. But the number of genera is small and other external characters prevent a confusion. Thus the Tapeworm which forms the subject of the present section cannot be confused with *Aploparaksis*, *Diorchis*, *Gryporhynchus*, *Paruterina*, *Culcitella*, *Oligorchis*, *Lateriporus*, *Dilepis*, *Davainea*, *Progynia*, *Idiogenes*, *Chapmannia*, *Proorchida*, *Monopylidium*, or *Cyclorchida*, since all of these have a circle or more than one circle of hooks upon the rostellum. There remains *Hymenolepis*, which is to be distinguished by

Text-fig. 156.



Thysanosoma gambianum, nat. size.

To the right are a few segments more highly magnified to show genital papilla.

possessing a "neck," which the present species does not, and by the limited series of testes in each proglottid. I am thus correct, as I believe, in regarding this worm as a member of the Anoplocephalidæ.

There are reasons both for and against referring the Tapeworm from the Gambian Pouched Rat to either of these genera or to a new genus, into which I shall enter at length after detailing its anatomy. This species is a large worm, measuring

some 6 inches in length. A very marked characteristic is the fact that the segments are wider than long throughout almost the whole of the body. It is only at the extreme end that they become longer. The segments overlap successively, so that it is possible to detect the anterior margin of each segment. The worm is not very stout, but flattened after the typical Tapeworm fashion; the most posterior segments alone being rather thicker in a dorso-ventral direction. The diameter of the body in the middle is some 6 mm. There is no marked colour, though, as will be seen presently, there is some internal pigmentation. The general character of the segmentation suggests that the proglottides are not shed.

This species like *Anoplocephala* has no "neck," as it is termed, that is to say, there is no undifferentiated zone following the scolex,

Text-fig. 157.



Scolex of *Thysanosoma gambianum*.

where the limits of the proglottides are unrecognisable. The definite proglottides are obvious from the very first. They are at first rather narrower than they become posteriorly; but the diameter of the body very soon attains to its full dimensions.

The cirrus of each segment is not visible, or at least not conspicuous, when the worm is viewed with a lens, in a protruded condition. This is due to the small size of these organs, which will be more fully described later. I have not found it possible to differentiate the ventral from the dorsal surface. The scolex, as already stated, is unarmed. I investigated this part of the worm by the section method, and am therefore able to state positively that there is no rostellum nor any trace of hooks. Nor do the suckers show any hooks that I could detect. I am convinced that they are absent altogether from the scolex of this worm. A regular series of transverse sections across the "head" shows a rostellar region above the region of the suckers, which is oblong in section; it contains no pit or depression of any kind that was obvious to me. The suckers are the usual four and as usual symmetrical. When the scolex is viewed in its entirety under a low power of the microscope the suckers seem to face rather upwards; but they do not lie on the upper side of the head as in some *Tetracotylea*. There is only a slight obliquity. The orifice of the sucker in such a preparation is very plain and rounded. There is no appearance of a slit-like orifice such as is described in the present paper in *Oochoristica*, and certain details in the minute structure of the suckers in these two genera show corresponding differences. I find in two series of transverse sections of the suckers of the two Tapeworms, that in the present species eleven or twelve sections displayed the entire sucker, of which only five showed its cup-like orifice; in *Oochoristica*, on the other hand, the entire sucker required seventeen sections of equal thickness for its display, of which twelve or thirteen showed the obviously more slit-like orifice.

As in *Oochoristica* the orifice of the external integument is much more limited than that of the sucker itself. The two coincided for only the space of two sections, rather less than in *Oochoristica*. This, however, I take to be simply a measure of the state of contraction of the suckers. It is also important to notice that the outer integument is grooved for a little space anteriorly to the appearance of the sucker itself, which suggests a confirmation of a view already put forward, and that is the independence of the suckers of the more specialised Tapeworms from the bothria of the Dibothriata. It appears to be possible that this grooving is the persistent trace of the bothrium, upon which the sucker has been added as a subsequent development.

In series of transverse sections through the head there is another feature of the suckers which deserves mention. It is very clear from such sections that the growth of the sucker has taken place in a definite direction:

Although I am unable to give histological details, it is certainly the fact that anteriorly the sucker is in organic connection with the general tissues of the head. There is no break; it begins gradually with a recognisable condensation of tissue marked by its deeper staining with carmine. On the other hand, at the

posterior end of the sucker its tissues come to an abrupt end, and I invariably found a shallow cavity between the sucker and the medullary tissue of the head. This suggests that the original position of the sucker is more apical and that it is directed upwards—a state of affairs which is actually seen to persist in many species of *Tetracotylea*.

The orifices of the generative organs are, as already stated, completely unilateral. I have examined pieces of the worm mounted whole, and many series of sections, and find that in every case there is a regular sequence of the apertures which lie upon one side of the body*. These orifices are not conspicuous on examination with a lens, as they are in many Tapeworms, and for two reasons. In the first place, the orifices are actually small, and in the second place, I have never observed the cirrus to protrude. Thus it is necessary to make a microscopical examination in order to detect the genital pores. Apart from microscopic sections, where, of course, it is easy to find the pores, I have only observed them (that is, in pieces of the worm mounted entire) in the wider posterior segments. Here they are seen to lie at just about the middle of the proglottides. The orifices project slightly and are quite circular.

The *excretory system* of this Tapeworm presents certain unusual features. In transverse sections through some of the middle segments of the body there are four longitudinal canals perfectly obvious in the body and no more than four, unlike, for instance, the genus *Oochoristica*, with which the present genus has some characters in common. These four tubes are lateral in position, and are all of them at about the same level. It is thus impossible by position to distinguish the dorsal from the ventral excretory canals. The two on each side are at a considerable distance apart. The distance which separates the outer from the inner of the two is about as great as that which separates the outer tube from the nearest margin of the body. The tubes can, however, be differentiated by their size. The outermost of the two excretory canals is not more than one-third of the diameter of the innermost tube. The form is not, however, so small that it can be missed in transverse sections. In the very anterior segments I have noticed a third lateral vessel on each side; and in this region of the body, moreover, the two main tubes have a greater inclination respectively to the dorsal or ventral side. There is an abundant plexus of vessels connected with these and traversing the proglottides, but I am unable to give details. I think, however, that I have seen numerous external pores.

The *testes* have a somewhat peculiar arrangement, which is distinctive of this worm. The bulk of these very numerous gonads lie upon that side of the body upon which the generative

* I cannot determine whether this is right or left with certainty, since in transverse sections the gonads are not definitely dorsal or ventral in position, *i. e.* nearer to one surface of the proglottid or the other, while the dorsal and ventral excretory tubes are parallel to each other and lie in the same plane with the nerve-cord.

pores are *not* situated. They are naturally in the medullary part of the body, and in transverse sections are seen to occupy the greater part of this, being neither dorsal nor ventral in position, but simply central. They reach towards the margin of the segment which is nearest to them, far beyond the outermost of the two excretory tubes of their side of the body—in fact, up to the nerve-cord; medianly they do not reach the median line of the body, but extend beyond the innermost of the two excretory tubes. They occupy perhaps, when seen in this view, one-fourth of the entire breadth of a proglottid. They are not very close together and are, at most, in two rows dorso-ventrally, there being thirteen or fourteen to each row, and thus something like thirty may be visible in a single section. In longitudinal sections seven or eight of these double or partly single rows are seen, and they may be observed to occupy the greater part of the segment. There is also a second set of testes at the opposite margin of the proglottid, very much fewer in number—perhaps four or five in a transverse row, which lie on either side of the outer excretory tube.

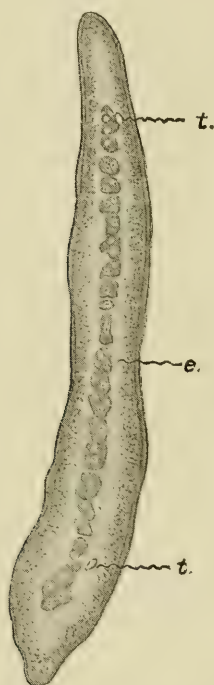
The *ovary* may be regarded as a paired structure, and the two are partly separated by the yolk-gland, which lies between and behind them. In transverse sections through the ovaries, before the other parts of the female reproductive system have been reached, each ovary is seen to be distinct from its fellow and to lie on either side and below the larger of the two excretory tubes, which, in such a section, is seen to be not median in position. The excretory vessel is here only just below the cortical layer of the proglottid, though actually in the medullary layer. The two ovaries are not quite in contact below the vessel, or, at any rate, they can be recognised as two distinct bodies of a bushy form not unlike that which has been figured in other Tapeworms. Within a few sections from that which has served as the basis of the above description the shell-gland is seen taking the place of part of that ovary which lies median of, *i. e.* not to the pore side of, the excretory vessel, and the oviduct leading from it to the ovary of that side is conspicuous. In a section or so further on in the series the yolk-gland appears; although, as already said, this gland divides the two ovaries, it does not lie symmetrically with reference to the excretory tube. It lies almost entirely on the median side of this tube but also below it, though it does not extend at all on to the pore side of the excretory vessel. It occupies nearly the whole of the space on the inner median side of the excretory tube that, in previous sections, is occupied by the ovary of that side. In the next proglottid to that whose ovaries and associated glands have just been described, the ovary to the outside reached nearer to the outermost and smaller of the two laterally placed excretory tubes, but without arriving at it. In this case it is important to notice that there was no accessory group of testes lying between the ovary and the outermost of the two excretory vessels such as occur in the proglottid first

described, and which are referred to elsewhere in the description of this species. Series of longitudinal (sagittal and horizontal) sections brought out the position of the ovaries and their relationship to adjacent glands still more clearly. Such sections also showed that the gonads are quite in the middle of the proglottid, *i. e.* dorso-ventrally. It should be remarked that the double character of the ovary was not always so strongly marked, and that it sometimes lay entirely upon the pore side of the more median (and larger) excretory vessel. Furthermore, I have also observed the yolk-gland to lie upon the median side of the larger excretory tube as well as upon the pore side. There is thus some variability.

It is, perhaps, noteworthy that the gonads of the pore side, which consist of the ovary, yolk-gland, and the testes, together occupy about the same space as the gonad and testes only, in this case, of the opposite side of the proglottid. The female gonads, at any rate, are visible very early in the body, within twenty segments, I dare say, of the head. Shortly after their commencement the mass of tissue which is to form ovary, yolk-gland, and, as I presume, oviduct, vagina, &c., is seen very plainly to extend towards the periphery of the proglottid between the two longitudinal excretory vessels, a feature of systematic importance in this group which it is necessary to note. In the sexually mature proglottides the oviduct runs straight from the ovary as a thin-walled delicate tube not easy to see, which is sometimes wider, at least near to its termination, in the ejaculatory apparatus, runs to near the distal termination, and then suddenly narrows into a very fine tube with thick, darkly-stained walls which, after a very short course, again suddenly widens into a long sac which is as wide as the cirrus sac and runs beside it and below in position. This terminal reservoir is laxly surrounded by what appears to be an adventitious sheath of muscular fibres, which have a circular direction and thus appear cut across; they are very obvious through their deep staining. This layer of muscles was sometimes, but not always, observed to commence with the very thin region of the vagina. The wide terminal region of the vagina bends towards the cirrus sac and again becomes narrow, opening in common with the latter into the genital cloaca, which is very short. This genital cloaca is quite distinct from an ingrowth of the outer layer of the body which meets it and forms the actual pore; this has been described in considering the external characters. The cirrus sac, as already implied, is neither wide nor long. The cirrus was never seen in a protruded condition, but always lay a darkly staining rod within the pouch. The vas deferens, directly it leaves the cirrus sac, is thrown into a large and complicated coil, which reaches for a considerable distance into the interior of the body. I think that it ends in a dilated vesicula seminalis above the ovary; there is, in any case, a dilated pouch in this region full of sperm, which does not appear to have anything to do with the female ducts.

In sections through the posterior segment of the body, the ripe eggs, with their sacs, are seen to occupy the whole of the available space, that being, of course, the medullary region of the proglottid. The segments are, in fact, stuffed full of eggs, and, in accordance with this, their dorso-ventral diameter has somewhat increased, though not to so very great an extent as in some other Tapeworms, for instance, in certain specimens of the *Oochoristica* described in the present paper. A closer examination of the eggs shows that they are imbedded a few together in a dense and darkly staining

Text-fig. 158.

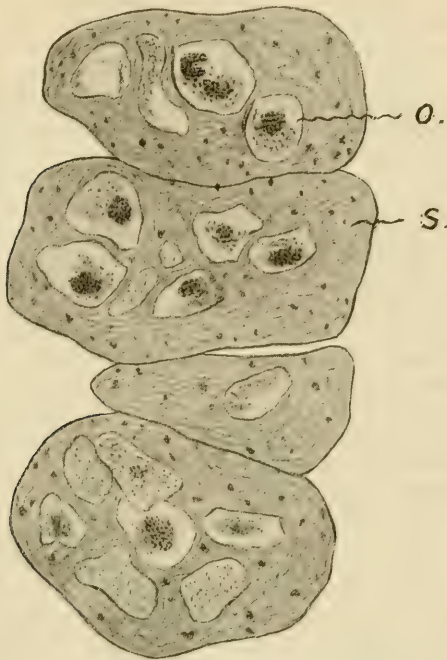


Transverse section through proglottid of *Thysanosoma gambianum* to show numerous paruterine organs (*e.*). *t.* Water-vessels.

mass of tissue, which closely invests them. These sacs appear to me to be, without doubt, the equivalents of the paruterine organs of many Cestoidea. They are not precisely sacs, in that there is no central lumen occupied by the eggs; they are rather concentrations of the medullary tissue round a series of eggs. These bodies are of approximately equal size and contain much the same number of eggs or, rather, embryos. There is no question here of a circle of paruterine organs surrounding a centrally placed

uterus. The uterus has entirely vanished, and the paruterine organs are imbedded in the tissues of the body.

Text-fig. 159.



Paruterine organs of *Thysanosoma gambianum* more highly magnified.

S. Walls of paruterine sacs. O. Embryos.

So much for the condition in the fully ripe proglottides. Earlier in the body this formation of paruterine sacs is preceded by a uterus which is not very conspicuous, and consists of not much more than a transversely running tube extending nearly right across the proglottid in which the eggs occur, but with which the uterus never appears to be stuffed. I could find no outgrowths of this centrally placed uterus, and there was certainly nothing in the nature of a reticular formation of its cavity. Gradually the cavity of the uterus appeared, as it were, to dry up and the eggs were found—to continue the simile—stranded in the tissue of the body. At this time the formation of the paruterine sacs became visible. Round each egg, or round two or three, as the case might be, the tissue of the medullary region of the proglottid became denser, this being shown by its darker staining. There was thus a concentration of tissue round the ova. This concentration of tissue had no relations that I could detect with the

uterus. There was nothing like the formation of diverticula of the latter walled by the condensed parenchyma.

The characters of this worm may be briefly summed up as follows:—

Strobila unarmed, with no rostellum, only a raised area. Strobila commencing without an intermediate neck. Proglottides much wider than long, except at the very end of the body. Proglottides very numerous, the length of worm being some 6 inches with a greatest diameter of 6 mm. Genital pores unilateral. Excretory tubes four, parallel to each other. Cortical layer of body as thick as medullary. Testes chiefly massed upon the side of the body furthest from the genital pore, very numerous, median in position. In addition, a small number of similar testes on either side of the outermost excretory vessel of the pore side of the proglottid. Vas deferens with a large coil and a vesicula seminalis above ovary; cirrus sac not long. Genital cloaca small, with circular muscles. Ovaries double, on either side of innermost of excretory tubes of pore side of segment. Yolk-gland on one side of same excretory vessel behind ovary. Shell-gland nearer to the middle of the body above the yolk-gland. Seminal receptacle, long and not much swollen, begins soon after the terminal chamber of the vagina. Uterus broad and sac-like, occupying a great deal of the middle of the proglottid. Many paruterine organs present in later stages.

The characters given in the above paragraph are not distinctive of any known genus of Tetracotylea. And I am, indeed, disposed to think that ultimately it will be necessary to form a separate genus for this worm from the Gambian Pouched Rat. In the meantime, however, I do not burden zoological nomenclature with an additional name until the possibility of its distinctness becomes more settled. Besides it is also possible that the existence of this species removes a barrier between the two genera *Thysanosoma* and *Anoplocephala*. Until I had become aware of the numerous paruterine organs, I was disposed to refer the worm to *Anoplocephala*, with which genus it obviously has many points in common. But the existence of these characteristic paruterine organs—and in such great numbers—is a reason for removing it from *Anoplocephala* and uniting it with *Thysanosoma*. On the other hand, the latter genus has either double or single sets of generative organs, and, correspondingly, either two pores upon each proglottid or alternating pores, while the Tetracotylean described in the foregoing pages has generative pores all upon one side. Nevertheless, the double set of testes seems to be a last trace of an originally completely double set of gonads and ducts, such as occurs in some proglottides of other *Thysanosomas*. If the small set of the testes existing in this species upon the pore side of the ovaries were to disappear it would be, as I think, impossible to separate this genus from *Anoplocephala* or *Zschokkeella*; but the definition of those genera would have to be enlarged in order to take in the numerous paruterine organs, which is, after all, perhaps the chief reason for referring this worm to the subfamily *Thysanosominae* which is mainly thus characterised.

30. On the Natural History of Whalebone Whales.

By J. A. MÖRCH, (Christiania) *.

[Received March 3, 1911: Read April 4, 1911.]

(Text-figures 160-163.)

No period in the annals of modern whaling exhibits such an intense activity as that which has been developed during the course of the last two years, after the pioneer expeditions of the preceding years to antarctic, subantarctic, and other waters in the Southern Hemisphere had demonstrated the wealth of Cetacea which is to be found in some of these localities. The rise in the price of oil to figures which, through shortage in the crop of oil-seeds, have not been obtained for the last twenty-five years, has had a further stimulating effect upon the development of this pursuit in those southern waters.

The situation to-day, then, is that, after the short run of six years, whaling in the Southern Hemisphere has attained a commercial importance entirely overshadowing that of the industry in our northern latitudes, which is now more than forty years old. As an example, it may be mentioned that last season, from the island of South Georgia alone, fourteen whaling steamers brought 106,800 barrels of oil, which is more than the world's total production of whale-oil three years ago!

Even during the latter part of the last century the attention of Norwegian whalers was directed to these distant regions; and in 1893 two expeditions started from Norway to try their luck in the chase of Seals and Right Whales in southern seas. One, in the 'Antarctic,' proceeded to Australian waters, and the other, in the 'Jason,' to the islands south-east of Cape Horn. The pecuniary results were not encouraging, and further attempts were given up for the time. Then came the Nordenskiöld scientific expedition in 1901, and Capt. C. A. Larsen, in the 'Antarctic' belonging to that expedition, had an opportunity of continuing his observations made during his previous voyage in the 'Jason.' Having satisfied himself of the seemingly limitless numbers of whales in those waters, he succeeded, in 1904, in interesting parties in Argentina in his plan for establishing a whaling-station on the island of South Georgia; and he began operations there about the new year, 1905.

Meanwhile, in 1903, the Norwegian Storting had passed a law prohibiting whaling on the northern coasts of Norway, and the now homeless whalers had to go in search of other fields for their operations. In the spring of that year a comparatively small vessel was fitted out as a floating factory and dispatched to Spitzbergen as an experiment. This proved successful; and in the next summer a larger vessel proceeded to these waters,

* Communicated by S. F. HARMER, Sc.D., F.R.S., V.P.Z.S.

with the same result. The floating factory, which was going to play such an important part in the development of modern whaling, became hereby an established fact; and in October 1905 this same vessel, together with two whaling steamers, was dispatched to the Falkland Islands and South Shetland. Upon the vessel's successful return with a nearly full cargo of oil in June 1906 the ice was broken; and now followed with intense activity the fitting out of a number of floating factories, as also of buildings and appliances for the erection of land stations in various localities in the Southern Hemisphere.

Text-fig. 160.



Floating factory and whaling steamer in harbour, Deception Island, South Shetland; with floating carcasses of Humpbacks.

From the southern coasts of South America, South Shetland, the Falkland Islands, South Georgia, the coasts of South Africa, and Kerguelen Island, whaling is now being prosecuted with an ever-increasing number of whaling steamers and with returns of oil undreamt of only a few years ago.

The species which are principally hunted are the Humpback Whale (*Megaptera boops*), the Blue Whale (*Baleenoptera sibbaldii*), and the Finback Whale (*B. musculus*); and, in one locality (the Falkland Islands), the "Seihval" or Rudolphi's Whale (*B. borealis*), which also occurs on the coast of Chili and the west coast of South Africa without having been actually hunted there yet.

The Sperm Whale (*Physeter macrocephalus*) and the Southern Right Whale (*Balæna australis*) are occasional visitors in some of the localities; the latter species having been observed nearly every year trekking in schools along South Georgia and towards the Patagonian coast. At South Shetland, Bottlenose Whales (*Hyperoodon rostratus*) have also been observed in small schools, but have not been the objects of pursuit. The appearance of this species near the coast in Bransfield Strait is interesting, but as none were caught no observations could be made upon what constitutes their food in this locality.

Humpbacks constitute the great bulk of the Whales caught in most of the above-mentioned localities. The cow of this species is supposed to go pregnant from ten to eleven months, and, judging from their numbers there, must be the most prolific of Whales. In February 1910 I observed at South Shetland two Humpback fetuses about $2\frac{1}{2}$ feet long which, if we accept the supposition of the late Prof. G. Guldberg as to the growth of Humpback fetuses, should be about $2\frac{1}{2}$ months old (impregnation, therefore, about the first of November). At South Georgia, I am informed, even at the commencement of the season, Humpbacks with calves from about 12 feet long are met with, and fetuses are also found here in their first months of development. According to these observations, the indications are that the Humpback Whales in these southern latitudes may be supposed to give birth to their young at some time in September or October, as against April and the neighbouring weeks in our northern latitudes.

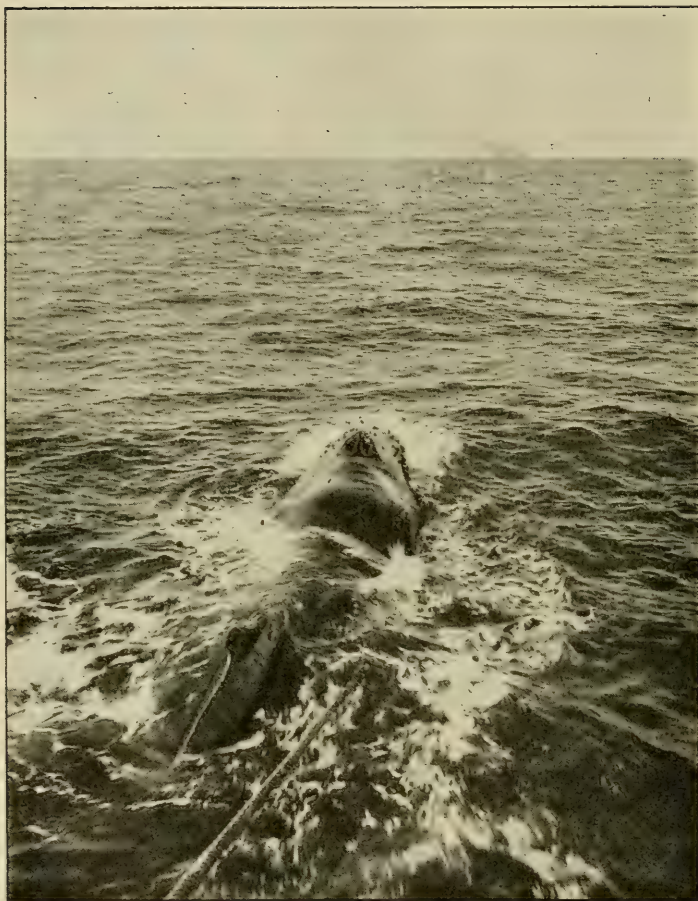
I may add that from the circumstance that in some of these southern localities the Whales are only flensed and the carcasses left to be driven by wind and tide, it is unfortunately only by the merest chance that observations upon the period of gestation of the various species can be made. As, however, a more appropriate disposition of the huge masses of meat and bones may be looked for in the future, opportunities should also present themselves for acquiring enough material for examination in this respect.

An interesting phenomenon is observed from South Georgia relating to the Humpback Whales. At certain times all the Humpbacks that are brought in have the belly nearly white; this variety may then disappear and those caught for some time may have the belly marbled; schools with their bellies entirely dark may then put in an appearance, succeeded by the first variety, and so on. At South Shetland I also observed these several varieties of the Humpback, although they did not there appear in distinct schools, but mingled. The bulls were here in a decided majority, and the individuals observed in February and March were mostly young.

A locality which is attracting serious attention at present is the western coast of South Africa. During the months May to October especially, the Humpback Whales have been observed in

great numbers and mostly off the coast of Portuguese West Africa. I think the question may reasonably be raised whether we have not here the great bulk of the Humpbacks from the South Georgia region on their annual migratory route? In this

Text-fig. 161.



Humpback Whale (nostrils open).

locality, which is interesting in more than one respect, observations might probably be made upon *fœtuses* of Humpback Whales in the later stages of their development. Large schools of Rudolphi's Whales and Blue Whales have also been observed

along these coasts, feeding upon plankton, but the few Blue Whales caught were all very lean.

The coast of Chili, from which whaling is at present being prosecuted, also offers opportunities for interesting observations upon the periods of gestation of various species of Whales, especially those of the Blue Whales and Rudolphi's Whales, which are very little known.

From a consular report which has come to my notice, it appears that great numbers of the Finback Whale congregate in the waters along the Brazil coast between South latitudes 12 and 18 every year during the period from May to November. Until more definite information is obtained upon this subject, further comment must, however, be reserved.

In the Northern Hemisphere, modern whaling is at present being prosecuted from the following localities:—Spitzbergen, Iceland, the Faeroe Islands, Shetland, the Hebrides, the western coast of Ireland, Newfoundland (one station also in Labrador), British Columbia, Japan, and Korea, while preparations are also being made for an early start in Alaska and in the Sea of Okhotsk from Saghalien Island.

When the veteran whaler Svend Foyn had perfected his harpoon-gun in the latter part of the sixties, and had commenced operations in Varangerfiord on the Finmark coast, the Blue Whales were his only objects of pursuit; and, so long as the hunting was carried on on a moderate scale, continued to be so for a series of years. As, however, after the expiration of his patent an increasing number of new companies entered the field, the other species of Whales—Finbacks, Humpbacks, and occasional schools of Rudolphi's Whales—also became the objects of the chase. Successively, however, the Blue Whales became scarcer and scarcer, and the other species of Whales, especially the Finbacks, came to play the principal part in the catches. The same order of things has, as a rule, repeated itself also in most other whaling-grounds in the North Atlantic.

As observations upon the breeding-season and the period of gestation of the various species of Whales in our northern latitudes can only be made during a limited part of the year, no exact information may be said to exist bearing fully upon these questions. The results from the Finmark coast may very briefly be summed up thus:—

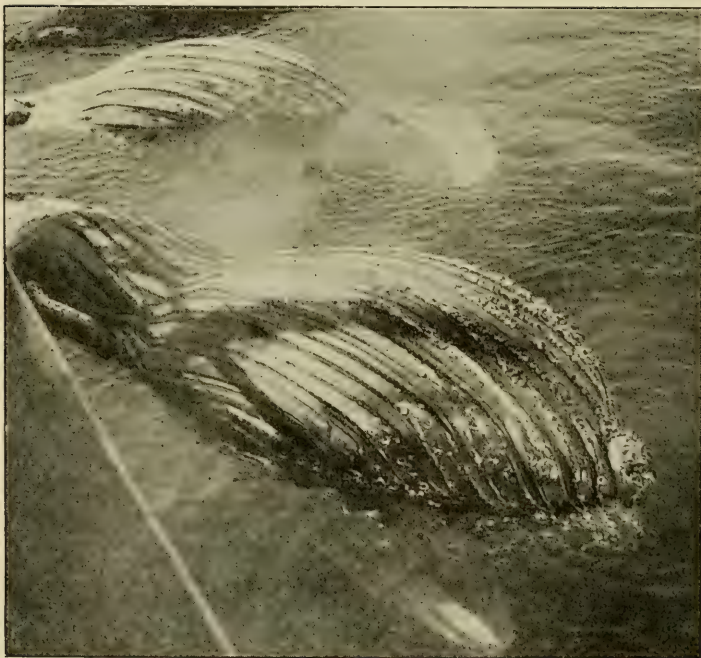
The *Blue Whales* have often been observed in coition during the summer; the indications are that this act may take place also at other times of the year. They have never been observed with small calves in that locality, but occasionally with larger ones. The period of gestation is supposed to last more than twelve months, and it is believed that there is no fixed time of the year when they give birth to their young; this probably takes place in American temperate waters*. Contents of the stomach of

* The Sulphur-bottom variety has occasionally been observed in Finmark waters.

various Blue Whales have been observed by Prof. G. O. Sars to consist chiefly of *Boreophausia inermis*. The Blue Whales are remarkably free from parasites, this perhaps owing to the circumstance that their outer skin easily peels off.

Finback Whales.—Impregnation is supposed to take place in January–March, and the period of gestation to be about twelve months. The length of the new-born calf is about 20 feet. Very young calves are always seen together with full-grown individuals in schools, older calves sometimes in schools by themselves. It is supposed in the locality in question that among 50–60 Finback cows 10–15 will have fœtuses and a lesser number will be accompanied by calves. Some cows give birth to their young in those waters, some go westwards to other localities. It is supposed that the cows do not become pregnant every year.

Text-fig. 162.

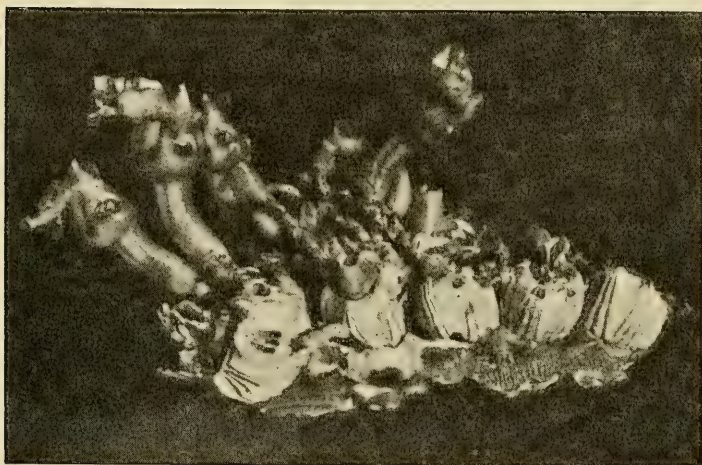


Typical site of Epizoic Crustacea on the ventral surface of a Humpback Whale.

As the Finback Whales in the North Atlantic feed on plankton, caplin (*Mallotus villosus*), and herrings, their distribution at most times of the year depends on the appearance of these various sorts of food. The whalers distinguish three varieties:

the blackish, the grey, and the yellowish. The blackish forms follow the schools of caplin and herrings. The time of appearance of the two other varieties seems to indicate that they feed chiefly on plankton. Further information upon the migratory route of these varieties would be interesting, and observations on the subject might be made during the progress of the herring fisheries. I may add that at South Shetland, in February and March, 1910, I observed several Finback and Blue Whales which were covered by a muddy, yellowish deposit which could easily be scraped off. As I had not a microscope with me, no information upon the nature of this substance could be obtained. *Pennella* is, so far as I know, the only parasite that has been found, and this only occasionally.

Text-fig. 163.



Epizoic Crustacea (*Coronula diadema* and *Conchoderma auritum*)
from Humpback Whale.

Humpback Whales.—During the early months of the year individuals of this species are met with on the Finmark coast going west. They are at that time followed by large calves, are restless, and approach the shores. About April the cows are supposed to give birth to their young in subtropical waters. Impregnation is supposed to take place shortly afterwards. The Humpbacks arrive again in the waters north of Finmark in summer; and around Bear Island they are found in July feeding on plankton (*Boreophausia inermis*, &c.) and caplin, and are then seen with calves about 20 feet long. The foetuses found at this time of the year are about 20 inches long. In September they go east into the Barents Sea, but observations upon their life during the last months of the year are wanting. They are

supposed then to feed on caplin and to follow the schools of these fishes near the "East Ice" and move westwards with them during the winter. Those killed on the westward trek have been found to have empty stomachs.

On account of the tough outer skins of the Humpback, parasites can easily fasten themselves thereto, and this species is, as a matter of fact, especially infested by various forms:—*Coronula diadema*, *Conchoderma auritum*, and *Paracystamus boopis*. *Pennella* is rarely found.

Rudolphi's Whales (*B. borealis*) are very erratic in their appearances. In 1884, for instance, only six were killed on the Finmark coast; in 1885, 659. This is a typical plankton Whale, and it appears on that coast only during the summer, feeding on *Calanus* &c. The fœtuses have a length of from 3 to 4 feet in June, from which it may be inferred that the cows give birth to their young during the latter months of the year in localities at present unknown.

In Shetland in 1906 I observed on a Rudolphi's Whale, which had the front end of its lower jaw deformed, a colony of *Conchoderma auritum* fastened thereto. This is the only instance of parasites on this species that I know of.

Plankton being the only or principal subsistence for the Whales in question, an exceedingly interesting problem is suggested:—What part do the great ocean currents play as highways and feeding grounds for these Whales during their annual migratory route?

From investigations carried on by Prof. Nansen and his assistants it has been proved that the cold polar water has a beneficial effect upon the vegetable life in the open sea. The cold polar currents, by mixing with waters of a higher temperature, create favourable conditions for the growth of plankton and higher marine life.

From these investigations, then, we may infer that it is along the border layers of the great polar currents where these meet and intermingle with warmer currents or waters that, given a sufficient activity of light for the production of vegetable plankton, we may expect to find the most favourable conditions for the subsistence of the plankton Whales.

We know from our northern latitudes that the waters along the northern coast of Iceland, Finmark, and along the western coast of Spitzbergen have attracted and been able to maintain for a long series of years a considerable or even a very great number of Whales.

On the contrary, we have seen that in localities which are under the principal influence of a cold polar current—for instance, the coast of Newfoundland—the stock of Whales has in the course of only a very limited number of years been seriously reduced, although the number of whaling steamers employed would not have been excessive had the same favourable conditions in the sea prevailed as, for instance, along the northern coast of Iceland.

The considerable number of Whales which were met with along the coast of Newfoundland during the earlier years of hunting may probably have accumulated, slowly, during the course of time by natural multiplication, *i.e.* the older ones have been followed by their young and these also have come back to the same locality. If the catches, then, had been proportional to the approximate natural increase, the industry might most probably have been carried on to the same extent for a long time to come.

It may be taken for granted that the great bulk of the Whales which during the spring months migrate northwards through the Atlantic take an easterly direction and spread in a fan-like manner towards Iceland, the Faeroe Islands, Shetland, Spitzbergen, and the northern coasts of Norway. Now the question is: Does the western part of the Atlantic bordering upon Nova Scotia, Cape Breton, and Newfoundland offer them any inducement in the form of sufficient food which they may be supposed to find at this time of the year growing along the border of the Gulf-Stream in various localities? This may, I think, be answered in the negative; and I believe that we have here also circumstances which may have contributed to the condition of things which has manifested itself off Newfoundland.

On the Murman Coast, also, there has been another instance of a similar case. In the eighties, two whaling stations were started here by the Russians, and under apparently favourable auspices as to the number of Whales which were seen in this locality. After a few seasons of successful hunting, however, the Whales became scarcer and scarcer, so that at last their pursuit had to be given up. This agrees also very well with our own experience on the Finmark coast, where the whaling stations in the eastern localities had to be moved westwards at a comparatively early date, as the Whales became scarcer in the colder areas towards the Murman Coast.

If the statistics of the Whale fisheries in some of our northern localities are examined, it will strike an observer that the years of good or poor returns generally run into periods of years of either the one or the other kind. There may one year be foggy or boisterous weather accounting for smaller catches, but these obstructions do not generally last in periods of years. It will take a closer study of the hydrobiological conditions of larger areas during the particular years to give a satisfactory explanation of this phenomenon, and I am only here indicating its existence.

With the latter part of August, or the first part of September, most of the Whales in our northern latitudes have left their summer haunts. The migratory routes of the Blue Whales and the Rudolphi's Whales between the seasons, and to some extent also during these, may well be said to be shrouded in mystery. The two American bomb-lances, which in the years 1888 and 1898 were found in Blue Whales on the coast of Finmark, do not give us much clue as to the particular locality where they had been fired into the animals.

Of the Finback Whales a considerable number must stay in our home waters also between successive summer seasons, following and feeding upon the shoals of caplin and herrings at various localities and times of the year. But their numbers are not so great as to account for the large schools which migrate to southern latitudes. In the Mediterranean considerable numbers of Finback Whales are seen, but further information from this locality is lacking.

In addition to what has been mentioned above with regard to the Humpback Whales, nothing is known about the migratory route of those which visit the waters off Newfoundland and northwards. It would be of interest to know if they follow the caplin in these localities, like the Humpbacks in the Barents Sea.

In the month of May, Humpbacks are found off the Azores, Bermuda Islands, and occasionally the Antilles. In 1899 parts of an American bomb-lance were found in a Humpback on the Finmark coast.

The part played by the Gulf-Stream in the biology of Whales in the North Atlantic is paralleled by the influence exerted by the Antarctic current or great West Wind Drift in the South Sea. The localities which have shown themselves to be rich whaling grounds, such as the coast of Chili, South Georgia, and the southern coast of West Africa, are under the influence of this current. By the intermingling of the cold waters from this current with waters from the adjacent warmer currents, conditions must be created favourable for the production of the masses of plankton which are sometimes seen in these localities. What part the Humboldt current along the western coast of South America and the Benguela current along the western coast of South Africa play as migratory routes and as feeding grounds during several months of the year for those species of Whales which at the present time are of the greatest commercial importance among the Cetacea, must be left to future investigations to disclose.

The geographical positions of the various whaling grounds in the Southern Hemisphere should offer special opportunities for observations upon the migrations, breeding-season, food, and other questions of biological and economical interest relating to these Whales.

EXHIBITIONS AND NOTICES.

April 25, 1911.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

THE SECRETARY read the following report on the additions to the Society's Menagerie during the month of March 1911:—

The number of registered additions to the Society's Menagerie during the month of March last was 270. Of these 73 were acquired by presentation, 137 by purchase, 45 were received on deposit, 8 in exchange, and 7 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 158.

Amongst the additions special attention may be directed to:—

2 Siamang Gibbons (*Symphalangus syndactylus*) ♀ ♀, from Sumatra, purchased on March 10th.

2 Neumann's Vervet Cercopithecues (*Cercopithecus centralis*), new to the Collection, from Lake Kivu, Central Africa, deposited on March 23rd.

2 Ruffed Lemurs (*Lemur varius*) ♂ ♀, from Madagascar, presented by Frederick Burgoyne, Esq., F.Z.S., on March 15th.

2 Pumas (*Felis concolor*), from Pernambuco, presented by John Sparks, Esq., F.Z.S., on March 11th.

1 Elephant-Seal (*Macrorhinus crozetensis*), new to the Collection, from the Crozet Islands, presented to The King's African Collection by Dr. Louis Péringuey, F.Z.S., and deposited by H.M. THE KING on March 23rd.

1 Gundlach's Troupial (*Quiscalus gundlachi*), new to the Collection, from the Greater Antilles, presented by the Countess of Suffolk on March 2nd.

MR. C. TATE REGAN, M.A., F.Z.S., exhibited a series of lantern-slides of scales of the Salmon (*Salmo salar*), and showed how the life-history of the fish could be read from its scales.

MR. D. SETH-SMITH, F.Z.S., the Society's Curator of Birds, exhibited:—

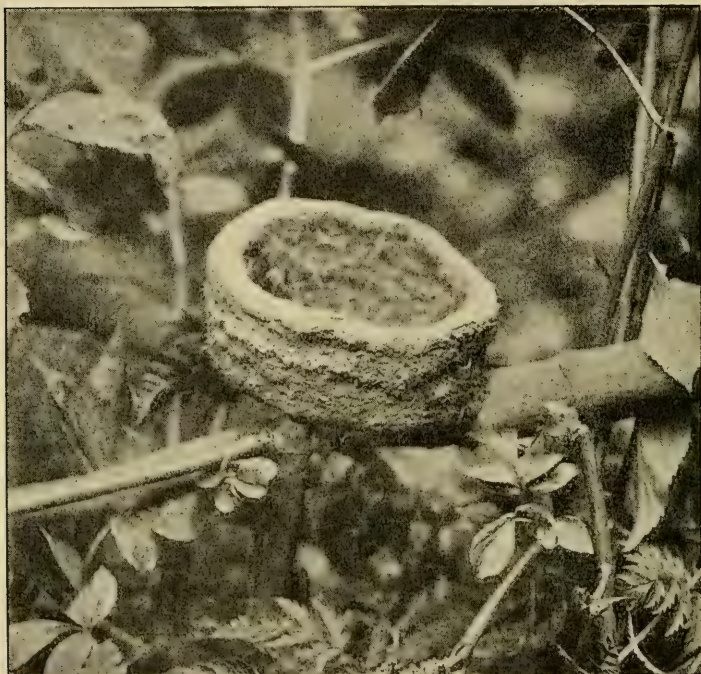
(1) A nest (text-fig. 164, p. 672) of the Grey Struthidea or Apostle Bird (*Struthidea cinerea*), composed entirely of mud, and built on a branch in the Western Aviary.

(2) Lantern-slides from photographs of the King Penguin (*Aptenodytes pennanti*) and Black-footed Penguins (*Spheniscus demersus*) showing the method of moulting.

(3) Lantern-slides of a number of wild Swainson's Lorikeets (*Trichoglossus nova-hollandiae*), from photographs kindly sent by Mrs. Innes, of Mackay, North Queensland. These birds came

in large numbers to feed daily at a table, on syrup provided, settling without fear upon the head, shoulders, and arms of the lady who fed them.

Text-fig. 164.



Nest of the Grey Struthidea.

Some Mammals from Uganda.

Dr. C. CHRISTY, F.Z.S., exhibited specimens from a collection of skins of antelopes, hyrax, monkey, cheetah, serval and servaline cat, &c., obtained in the Chagwe forests in the south-east of the Uganda Protectorate, and made the following remarks:—

“Perhaps the most interesting specimens in the collection before you are those of *Cephalophus weynsi*. This red duiker was first described by Mr. O. Thomas, F.R.S., from two skins from eastern Congo. Subsequently a specimen was obtained by Mr. L. M. Seth-Smith in the Budongo forest on the east of Lake Albert. An imperfect skin in the National Collection, labelled *Cephalophus johnstoni*, also obtained from the Lake Albert region, and described some time ago by Mr. Thomas, may possibly also belong to this species.

“My own four specimens were shot in the Mabira forests more

than 100 miles east of the Budonga, and with very little forest intervening. The locality is a new one, and is probably the easternmost limit of the species, which, after another gap of 150 miles of more or less open country still further east, gives place to *Cephalophus ignifer*, the common red duiker of the East African upland and rift-valley forests.

"The two species are closely allied. In both the body-hair is short and close-laid, and the horns slope backward in a line with the forehead. Amongst other characteristics *C. weynsi* may be distinguished by the hairs on the nape being reversed forward.

"These sleek, heavy, short-legged duikers are very pig-like in gait and appearance, carrying the head low. They are found only in dense forest, and, so far as my experience goes, never even feed in the open, unlike the grey duiker so commonly to be met with at forest-edges and often seen in the open. My two best heads of *C. weynsi* measure $4\frac{1}{4}$ and $4\frac{1}{2}$ inches in length respectively.

"I may also draw your attention to the specimens of hyrax—*Procavia emini* and *P. dorsalis* (?). Naturalists do not seem to quite realise that certain species of hyrax, the *Dendrohyrax* group, are entirely arboreal, never living amongst rocks or holes in the ground, but inhabiting the largest trees in dense tropical forests; whilst other species are rock dassies, and though able to run up and down the face of a perpendicular rock or even to play about the neighbouring bushes, yet are in no sense arboreal. The members of the *Dendrohyrax* group do not even live in hollow trees as a rule, but upon the branches.

"On looking closely at the skins of these two animals, *P. emini* and *P. dorsalis* (?), both killed in high trees, it is interesting to observe that the long bristles amongst the fur, so numerous and so conspicuous, especially on the hinder part of the body, in those species which are not arboreal, are here obviously absent or only to be found on the neck or shoulders. I find, as the result of an examination of the skins in the British Museum, that this distinctive peculiarity holds good for the two groups in almost every instance, the arboreal *Dendrohyrax* group being almost without them, while in the rock-inhabiting species they are very conspicuously developed, mainly posteriorly.

"It seems probable that these long stiff hairs are tactile organs and of very considerable use in dark burrows and holes amongst the rocks; whilst it is easy to see that they are of less utility on the branches of trees, and in time, no doubt, would become rudimentary or disappear altogether.

"The weird, nocturnal, ventriloquistic cries of both groups of these animals are even more extraordinary than their powers of climbing."

Dr. CHRISTY also exhibited a loin-cloth taken in 1898 from the dead body of a native in the Gando-Bornu district of Northern Nigeria. In referring to it, he said:—"When first I caught sight of this ornamental piece of wearing apparel it seemed so peculiar that I stopped to secure it under considerable difficulties.

It is apparently made from the skin of a young *Cobus cob*; but the white of the belly part and the inner part of the hind legs you will see are transversely striped with inch-wide stripes, some two or three inches apart, of a reddish-brown colouring exactly resembling that of the animal. These stripes are doubtless made with some native pigment or dye; but they are so placed and the colour is so permanent, so fixed and difficult to remove by any means, that serious doubts have been entertained, as Mr. Thomas will tell you, as to whether they were artificial or natural markings.

"It will be also noted that the white hair on the striped belly-parts is curled and not unlike sheep's wool, but quite unlike any known antelope. If this curling of the hair in this situation is not natural, I can only suggest that it is produced by the heat and chafing of the wearer's thighs."

Mr. Oldfield Thomas, in commenting upon Dr. Christy's exhibit, stated that there was little doubt that the stripes and curly appearance of the hair were artificial, but the fact that the dye, whatever it was, so closely resembled the natural colour of the animal and appeared to be so "fixed," the possibility of the skin belonging to some antelope hitherto quite unknown had been very carefully considered at the Natural History Museum.

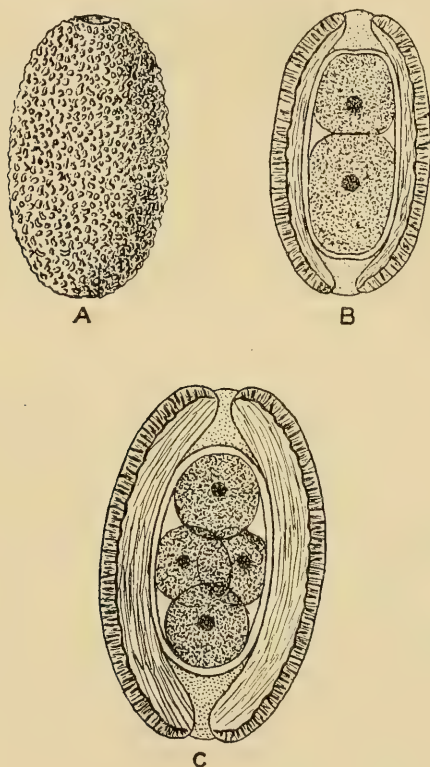
On a unique Pathological Condition in a Hare.

(Text-figure 165.)

Dr. WILLIAM NICOLL, M.A., F.Z.S., exhibited some preparations from a Common Hare (*Lepus europæus*), which showed an interesting and unique pathological condition. The hare was obtained by W. Raphael Muckley, Esq., and sent by him to the British Museum, whence it was forwarded to the Lister Institute of Preventive Medicine. The manner in which the hare died was somewhat remarkable. It was observed by Mr. Muckley to pitch violently out of a hedge on to the roadside where it lay struggling, and it died about three hours later. To him the symptoms seemed to point to poisoning. At the *post mortem* examination the liver was found to be extensively invaded with small whitish chalky deposits of various sizes, especially conspicuous on the posterior surface. There was also a considerable amount of chronic inflammation around the liver, with adhesions to the diaphragm. On section the liver was friable and gritty. The concretions were amorphous and insoluble in acid. The bile-ducts showed some fibrous thickening. On microscopic examination of a scraping from the liver, numerous ova of peculiar structure were seen. They were fairly uniform in size, measuring $\cdot 057 \times \cdot 033$ mm. At first sight they bore a considerable resemblance to the eggs of *Trichuris* (*Trichocephalus*) or *Trichosoma*, but on more careful inspection they presented one or two unusual features. The colour was much lighter, being greyish instead of brown. The shell consisted of two layers, the outer of which was marked with pronounced radial striations; the inner was

constituted of fine concentrically-arranged lamellæ. The two layers were not in close apposition but were separated by a narrow, somewhat irregular space. The egg is thus provided with a double shell. At each pole of the egg there was a small circular aperture, piercing both layers of the shell. The external surface of the shell presented a well-marked papillated appearance, the papillæ being irregularly rounded. Inside the shell

Text-fig. 165.



M.R., del.

Eggs of a Nematode worm from the liver of a Hare.

- A. External surface of egg. B. Optical section of egg: two-celled stage.
C. Egg in four-celled stage with thickened inner wall: from vagina.

there was a thin, continuous membrane investing the egg. The polar apertures were each closed by a plug of homogeneous material which was separate and distinct from the membrane investing the egg-cells. They completely filled the apertures but did not bulge beyond them. The eggs were mostly in the two-celled stage, but a number of them showed four cells.

From the appearance of the eggs it is obvious that the lesions were due to a Nematode worm of the *Trichosoma* group. Search was accordingly made and a number of worms were obtained. In every case, however, they were fragments lacking the anterior and posterior extremities. The longest specimen measured 27 mm. It was a female, full of eggs, and it was very slender. It was narrowest at the anterior end (.14 mm.), the breadth increasing gradually towards the posterior end where it was .23 mm. The cuticle was marked throughout with fine annular striations. The vagina was of considerable length but no genital aperture was seen, so that it must have been far forward. In the vagina a number of eggs were present, which were much larger than those first seen. They measured .070-.078 x .040-.045 mm. The shell, too, was much thicker, the increase being almost entirely due to a great thickening of the inner layer. The polar apertures were somewhat reduced in size and the eggs were for the most part in the four-celled stage.

The lesions in the liver showed much resemblance to those seen in advanced stages of coccidiosis, a very common condition in rabbits. For this reason they might readily be diagnosed as such on cursory examination. This, so far as can be gathered, is the first record of such an infection of the liver of hares or rabbits by parasitic nematodes of this kind.

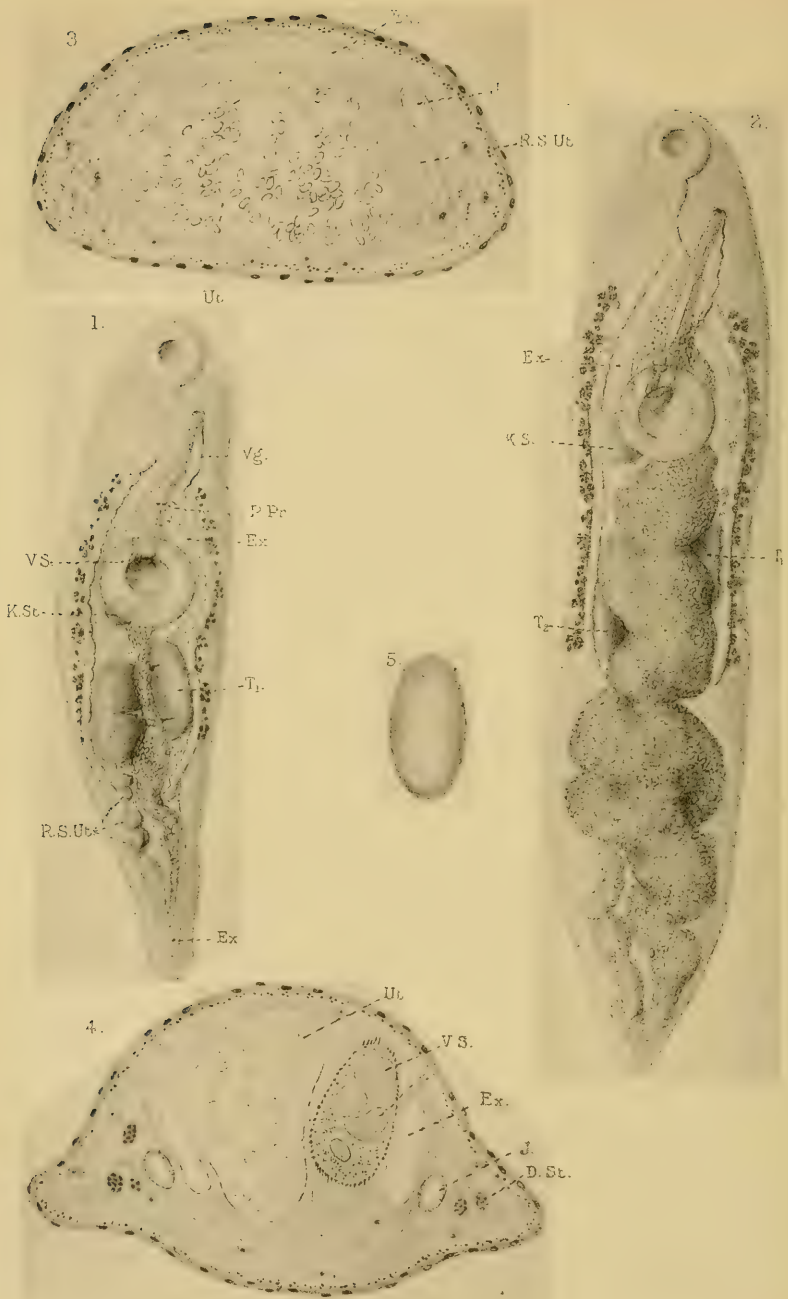
An analogous condition has not infrequently been met with in rats, and has been reported from Europe, India, and Australia. No record has been made of its occurrence in this country.

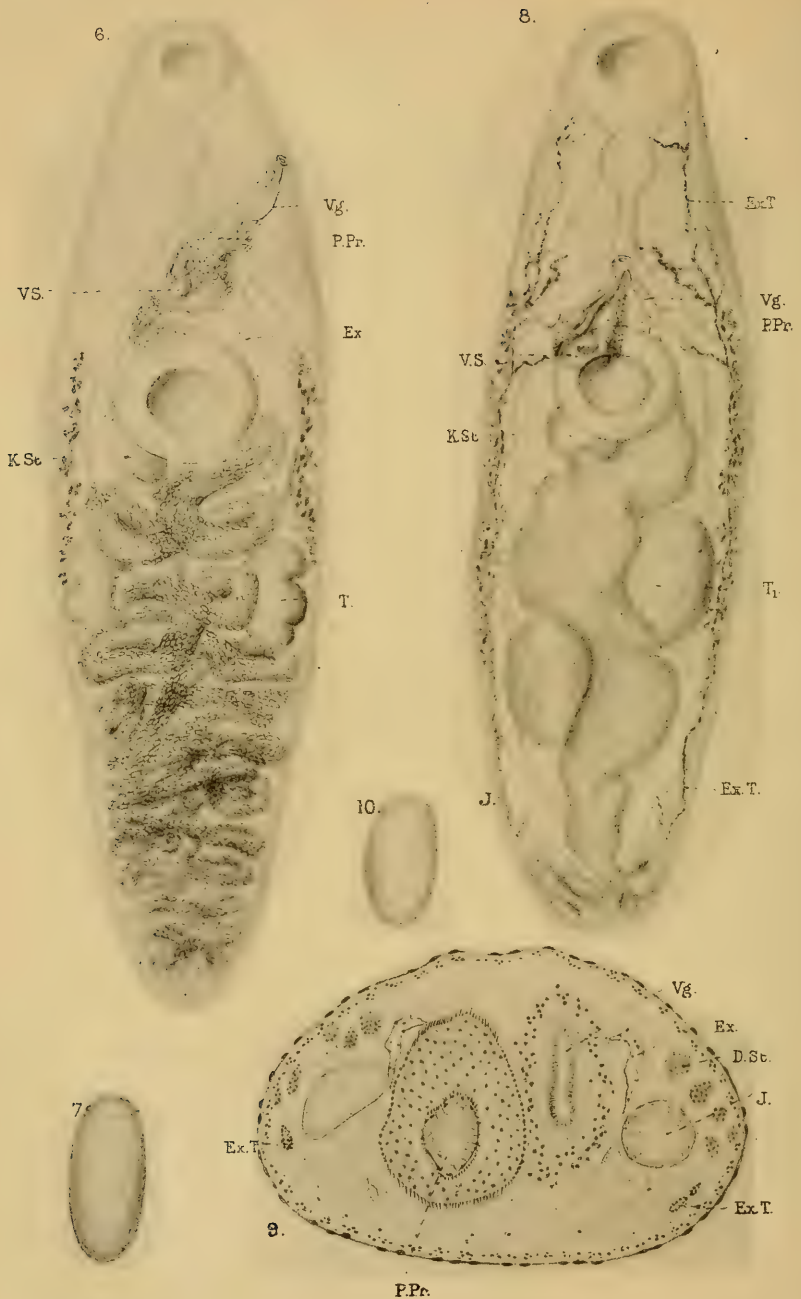
Whether this parasite in the hare is the same as that in the rat must remain doubtful, for the descriptions of the latter have hitherto not paid much attention to the character of the eggs beyond mentioning that they resembled those of *Trichosoma*.

An attempt is being made to hatch the eggs and to produce infection in rabbits and rats, but the development is extremely slow even at a constant temperature of 26° C.

In addition to the lesions in the liver the hare had a very heavy infection of *Trichostrongylus retortaeformis* in the intestine and a slight intestinal infection with *Coccidium cuniculi*. The intestine and the appendix, moreover, showed a large number of small calcareous patches, but on examination nothing of a parasitic nature could be detected in the patches. This was of interest from the fact that I had already seen similar patches in the cæcum of a Variable Hare, sent me from the Society's Gardens. The liver, unfortunately, was not submitted for examination. That these patches might have something to do with the liver condition was not impossible, for they might be considered as degeneration following injury such as the passage of a worm through the intestinal wall.

The hare, further, showed signs of recent parturition and there was a septic condition of the uterus, and it must remain an open question as to whether death was due to this or to the liver disease.





M Rhodes, del.

London Stereoscopic Co. Imp.

6. 7. OCHETOSOMA FORMOSUM.
8 - 10. DASYMETRA CONFERTA.

PAPERS.

31. On Three New Trematodes from Reptiles.

By WILLIAM NICOLL, M.A., D.Sc., M.B., F.Z.S.*

[Received December 29, 1910: Read April 25, 1911.]

(Plates XXVII. & XXVIII.†)

The following notes were made on a collection handed over to me by the Prosector of the Zoological Society. In no case was the habitat noted, but from their affinities it may be presumed that the specimens all came from the lungs, the mouth, or the cesophagus. The specimens are interesting as forming an important addition to our knowledge of the large variety of forms which inhabit the air-passages and anterior end of the alimentary canal of reptiles and batrachians. To the taxonomy of this particular group Odhner has recently (1910) made a valuable contribution, which will be further referred to later.

The first species is from the Hog-nosed Snake (*Heterodon platyrhinus*), and I include it provisionally in the genus *Lechriorchis* Stafford, 1904. Like most of Stafford's genera, this genus is insufficiently defined, although the fact that he includes in it the well-described species *L. (Renifer) elongatus* Pratt, 1903, is something to go upon. It is, therefore, necessary to amend Stafford's definition somewhat, as follows.

Genus LECHRIORCHIS Stafford, 1904.

Resembling *Renifer* Pratt, 1903, except in the following particulars. The intestinal diverticula extend a short distance beyond the testes; the genital aperture is further from the edge of the body, midway between it and the pharynx; there is a well-developed vagina.

These constitute, as far as appears, the only differences between the two genera.

LECHRIORCHIS VALIDUS, sp. n. (Plate XXVII. figs. 1-5.)

This is a species of moderate size, measuring 3.6-7.4 mm. in length by .9-1.4 mm. in breadth. The smallest specimens had just begun to produce ova, so that the minimum adult size is probably about 3 mm. The body is elongated, the length being 4-5 times the breadth. The latter is comparatively uniform, but the tail is distinctly pointed. The anterior end is more rounded, while there is a tendency for a slight narrowing to occur about or behind the ventral sucker. In young specimens the body is flattened, but it becomes much thicker as the uterus increases in size. In transverse section an adult specimen presents a strongly convex dorsal surface and a flat or slightly convex ventral surface.

* From the Lister Institute of Preventive Medicine, London.

† For explanation of the Plates see p. 686.

The cuticle is fairly thick, somewhat deciduous, and is studded throughout its whole extent by stout salient spines. These are regularly arranged, and become sparse towards the posterior end. The underlying musculature has the usual formation.

In an average adult specimen of 6.5 mm. length the oral sucker has a diameter of .45 mm. It is subterminal, globular, and its aperture has a marked muscular rim. The thickness of its wall is about .13 mm. In the same specimen the ventral sucker measures .66 mm. It is also globular, slightly flattened, and its wall is .18 mm. thick. The sucker ratio is, therefore, very approximately 2:3. The diameter of the sucker relative to the body-length diminishes as the animal increases in size. Thus, in the smaller specimens the ventral sucker is $\frac{1}{7}$ of the body-length, while in the largest it is only $\frac{1}{11}$. The ventral sucker is situated about $\frac{1}{3}$ of the body-length from the anterior end. In this respect, again, the young specimens differ from the older ones in that they have the ventral sucker relatively further back.

There is a very short prepharynx; usually the pharynx is contiguous with the oral sucker, and it measures $.23 \times .17$ mm. The œsophagus is about $\frac{3}{4}$ of the length of the pharynx, although it is longer in young specimens. The intestinal bifurcation takes place well in front of the ventral sucker. The intestinal diverticula run almost parallel to the edges of the body. They bend in a little just behind the ventral sucker, but they are pressed out again by the testes. At their termination, just behind the posterior testis, they usually turn in a little. Their ends are about $\frac{2}{5}$ of the body-length from the posterior end. They are comparatively narrow tubes, and their wall is crinkled on the inner side. The outer side is plain. They are lined by a layer of low epithelium. The œsophagus has the usual cuticular lining. Throughout their whole extent the diverticula are somewhat ventral in position.

The excretory system is characteristic and agrees with Odhner's supposition as to its form in the group to which this species belongs. The vesicle consists of a fairly broad main stem, opening at the tip of the tail and passing forwards to the shell-gland, where it divides into two limbs. These diverge to form a Y, and each passes over the edge of the ventral sucker and terminates halfway between the sucker and the intestinal bifurcation. The main stem is pressed close to the dorsal surface, but the limbs are not quite so dorsal in position. They eventually come to lie close up to the intestinal diverticula and separate these from the uterus and cirrus-pouch respectively (Pl. XXVII. fig. 4). The main stem is much compressed dorso-ventrally, but the limbs are round or compressed transversely. In addition to this central system, however, numerous lateral twigs are given off from the stem and limbs. These all radiate outwards towards the edges of the body, dividing and subdividing and eventually forming an intricate anastomosis (Pl. XXVII. fig. 3). The entire lateral fields of the body are thus filled with a complex network of excretory tubes, and the amount

of parenchymatous tissue is very much reduced. This is more particularly the case in the post-acetabular region. It gives rise to a reticulated appearance, which is strikingly seen in young specimens (Pl. XXVII. fig. 1). In older specimens it is obscured by the growth of the uterus.

The genital glands are difficult to distinguish in the adult, but are easily seen in younger specimens. The testes lie not very far behind the ventral sucker, near and internal to the ends of the intestinal diverticula. They are obliquely situated, the left testis being half its diameter in advance of the right, and they are separated from each other by the uterus. In a young specimen, the uterus being narrow, they lie quite close together, but they are pressed further and further apart by the growth of the uterus. They are flat, elongated oval bodies measuring at least $.8 \times .4$ mm. Their outer margin is plain, but their inner margin is indented in one or more places, so that the outline is somewhat irregular. At first they lie almost flat in the body, but the expansion of the uterus pushes their inner border towards the dorsal surface so that eventually they are considerably tilted.

The genital aperture is situated on the left side midway between the pharynx and the edge of the body. It is always on the level of the pharynx. The cirrus-pouch is of considerable length, and is a conspicuous object. It is elongated, somewhat slender, and extends to the middle of the ventral sucker. Its wall is remarkable for the great development of the longitudinal muscular fibres, which are stout and very prominent. The circular fibres are much smaller. Within the pouch there is a more or less highly convoluted vesicula seminalis. Usually it is simply bent double (Pl. XXVII. fig. 2), but frequently it is much more twisted. It is small compared with the size of the cirrus-pouch. It is not much dilated, and it is connected with the pars prostatica by a narrow duct. The pars prostatica is of relatively great length. It is an almost straight tube extending from a little in front of the ventral sucker to the point where the cirrus-pouch crosses the left intestinal diverticulum. It is uniform and fairly narrow. Surrounding it are numerous prostatic cells which fill up the greater part of the cirrus-pouch. The ductus ejaculatorius is short and narrow, and the exsertile, unarmed cirrus is not very long. The genital sinus is quite small.

The ovary is situated just behind the end of the cirrus-pouch, over the right posterior quadrant of the ventral sucker. Half of it lies beyond the sucker, and it frequently overlaps the adjacent intestinal diverticulum. It is an almost globular body, somewhat flattened dorso-ventrally, and is about half the size of the testes. Behind and internal to it lies a compact shell-gland, with a short ootype and a Laurer's canal, but no receptaculum seminis. Laurer's canal is short and opens dorsally in the middle line, about the level of the ovary. A small yolk reservoir lies dorsal to the shell-gland. The yolk-glands are of limited extent. They are entirely lateral and lie close to the outer side of the intestinal diverticula. On each side there are about half a dozen ill-defined

groups of follicles, which extend from midway between the intestinal bifurcation and the anterior edge of the ventral sucker to near the ends of the intestines. The initial part of the uterus is practically empty. In section it can be made out with difficulty as an extremely narrow tube, passing backwards from the shell-gland. Behind the right testis it widens out to form a receptaculum seminis uterinum, consisting of about four or five small dilatations. Further back a few ova appear, but the uterus still remains somewhat narrow. When it has nearly reached the posterior end of the body it turns abruptly on itself to form an ascending limb. Almost immediately this begins to dilate, and it has only proceeded a short distance before it almost completely fills the interior of the body. It passes forward, over and between the testes, crosses the ventral sucker, and terminates in a straight, thick-walled vagina, which is about half the length of the cirrus-pouch, and lies on the left side. The uterus thus consists of a descending and an ascending limb, the former being empty for the greater part of its length, and the latter being enormously dilated. The increase in size, therefore, takes place, not by an increase in convolutions, but by a great dilatation of the ascending limb. The ova are very numerous, rounded oblong in shape, and dark brown in colour. They have a large well-marked operculum. Many of them are more oval than oblong, and this gives rise to some variation in dimensions. From a large number of measurements the limits were found to be $\cdot038$ – $\cdot045$ mm. for the length, and $\cdot018$ – $\cdot023$ mm. for the breadth, and the average $\cdot040 \times \cdot021$ mm. The extreme sizes observed were $\cdot045 \times \cdot018$ mm. for the most oblong ova, and $\cdot038 \times \cdot023$ mm. for the most oval.

No case of amphitopy was observed in any of the two dozen specimens forming the collection. The nearest approach was in one specimen where the testes were practically symmetrical, the left being a trifle behind the right, but the ovary and genital aperture were normal. In all the other specimens the position of these structures was exactly as I have described. The species, however, is extremely variable in one respect, namely, the posterior limit of the yolk-glands. Hardly two specimens agree in this respect. In some specimens they extend a short distance beyond the testes, in others they reach the middle of the posterior testis, and again in others they stop short of the testes. In addition, they are very frequently asymmetrical, extending further back on the right than on the left, or more rarely *vice versa*. The fact, however, that their anterior limit is constantly symmetrical induced me to consider a symmetrical posterior limit as the normal. In two specimens also, the intestinal diverticula were of unequal length, the left diverticulum being considerably shorter than the right, which was normal. The position of the genital aperture varied only very slightly, and most of the apparent variations were due to contraction. The length of the cirrus-pouch was practically constant, although in one specimen it extended nearly to the posterior border of the ventral sucker. The size of the ova was constant within the limits noted, and no increase in size takes

place as the animal grows older. The average size of the ova in young specimens was found to be the same as that in fully grown specimens, and I am inclined to view with some doubt Odhner's statement (2. p. 59) that the ova in *Renifer sauromates* Poir. increase in size as the animal grows older.

From *Lechriorchis elongatus* Pratt, this species is distinguished by having more unequal suckers, the ventral being decidedly larger, the yolk-glands being more extensive, being present some distance in front of the ventral sucker, and in having slightly larger eggs. From *L. primus* Staff., it appears to be distinguished by its much smaller eggs, its smaller ventral sucker, and probably in other respects.

The second lot of specimens consists of five from an Annulated Snake (*Leptodira annulata*). They bear a close superficial resemblance to *Lechriorchis validus*, but they do not belong to the same genus. The only genus to which they can at present be referred is *Ochetosoma* Braun, 1902, but they do not entirely agree with the definition of that genus as given by Braun. In internal anatomy they correspond quite closely, but they are not nearly so flattened as *O. monstuosum* Brn., the only species of the genus. The only other genus to which they could be referred is *Renifer* Pratt, 1903, but from that they differ radically in the configuration of the uterus.

OCHETOSOMA FORMOSUM, sp. n. (Plate XXVIII. figs. 6 & 7.)

The body is elongated and slightly flattened. The length is 3.7–5.7 mm., and the greatest breadth, about the ventral sucker, is 1.1–1.6 mm. The breadth is therefore rather less than $\frac{1}{3}$ of the length. The body tapers gradually towards each end.

In an average specimen (length 4.5 mm.) the oral sucker has a diameter of .45 mm., i. e. $\frac{1}{10}$ of the body-length. It is globular and subterminal. The ventral sucker is situated 1.7 mm. from the anterior end. It is slightly oval, the transverse diameter being .64 mm., and the longitudinal .57 mm. The sucker ratio is therefore approximately 3 : 4.

The cuticle is extremely deciduous; in most of the specimens it was almost entirely stripped off. Only in one was it intact, and even then not completely so; from this specimen the presence of minute regular spines was determined.

There is a short prepharynx followed by an almost globular pharynx, measuring .17 × .16 mm. The œsophagus is about the same length as the pharynx (.2 mm.), and the intestinal bifurcation occurs well in front of the ventral sucker. The diverticula diverge pretty widely, and they terminate almost immediately behind the ventral sucker, the ends being somewhat turned in. They are narrow and irregularly dilated, but there is no crenation on their inner wall as in *Lechriorchis validus*. They are lined by low epithelium.

The excretory system is almost identical with that in *Lechriorchis validus*. The vesicle consists of a similar dorsal main stem, which

divides just behind the ovary into two limbs, which pass forwards a short distance in front of the ventral sucker. They are thus not so long as in the above mentioned species. The main stem, too, appears more expanded. There is the same system of secondary lateral branches which anastomose freely in the sides of the body.

The genital aperture is situated almost at the extreme left margin of the body, on the level of the posterior end of the pharynx. The genital sinus is very small. The cirrus-pouch is very like that of *Lechriorchis validus*, but it is shorter. It is usually disposed obliquely, and it terminates a short distance in front of the ventral sucker, from which its end is usually separated by a coil of the uterus. In one specimen it almost reached the sucker. It contains a small convoluted vesicula seminalis, ending in a narrow portion which runs into the pars prostatica. The latter is not so long as in the foregoing species, and it is more expanded, especially at its posterior end. The prostatic cells are numerous. There is a short ductus ejaculatorius, and an unarmed cirrus of moderate length. The testes are situated just behind the middle of the body (.3 mm. behind the ventral sucker). They are symmetrical and lateral. They lie behind the ends of the intestines, but are separated from them by folds of the uterus. The length of each is about .5 mm. They are fairly thick and elongated, and their outer margin is always distinctly divided into three large lobes, which may in addition be slightly crenated. The inner margins are completely obscured by the overlying folds of the uterus.

The ovary is situated over the right posterior quadrant of the ventral sucker and projects half beyond it. It is obliquely ovoid and measures .24 x .17 mm. A large shell-gland lies close to its inner side. The yolk-glands are entirely lateral and of limited extent. They reach from the anterior border of the ventral sucker to about the middle of the testes. Again in this species, however, the posterior limit is extremely variable, and may be anywhere between the anterior and posterior borders of the testes, but never beyond them. The anterior limit is practically constant. The uterus fills almost the whole of the post-acetabular region, but its configuration is entirely different from that in *Lechriorchis*. Here, again, the descending limb is small and almost empty; reaching the posterior end of the body it turns into the ascending limb. In this case, however, accommodation for the enormous number of ova is obtained not by excessive dilatation, but by numerous convolutions, the diameter of the uterus not being very greatly increased. The convolutions have a markedly transverse disposition, extending from side to side of the body. In the region of the testes the convolutions are shorter and stouter. An additional small convolution is formed in front of the ventral sucker. The uterus terminates in a well-marked vagina, which is about a third of the length of the cirrus-pouch. The ova are very like those of *Lechriorchis validus*, but are usually more oval. They have a large distinctly-marked operculum, and

they vary in length from .034 mm. to .042 mm. by .017 mm. to .021 mm. in breadth. The average is about $.4 \times .2$ mm.

In this species, again, no case of amphitypy was observed, and the only pronounced variation was in respect of the posterior limit of the yolk-glands as described above.

The species obviously presents a close resemblance to the genus *Renifer* Pratt, *sens. strict.* In the shortness of the intestinal diverticula, the symmetrical situation of the testes, and the extreme lateral position of the genital aperture, the agreement is complete. The essential difference lies in the configuration of the uterus. *Renifer ellipticus* Pratt, the type species, is unfortunately not fully grown and the ultimate disposition is not apparent. In *R. sauromates* Poirier, the uterus is of the same type as in *Lechriorchis validus*, and if this be taken as characteristic of the genus, then *O. formosum* must be separated from that genus.

It is evident that the three genera *Renifer*, *Lechriorchis*, and *Ochetosoma* are somewhat closely related, and they differ from all the other members of the family Lepodermatidae in the extreme lateral and forward position of the genital aperture. They evidently form the nucleus of a group, but the extremely profuse variety met with in the family renders it somewhat difficult to divide it into definite subfamilies. Provisionally, however, these three genera may be classified under Pratt's subfamily Reniferinae. That *Pneumatophilus* Odhn., and *Leptophallus* Lühe, are to be included along with these, as Odhner has indicated (2. p. 56), appears to me somewhat doubtful.

The third form which I have to describe here is one of very great interest. It was obtained from a Diamond Water-snake (*Tropidonotus rhombifer*) from North America. The habitat, unfortunately, is not recorded. It bears a certain resemblance to the foregoing species, and belongs to the family Lepodermatidae, but it possesses an individuality sufficiently marked to constitute a distinct generic type.

DASYMETRA CONFERTA, gen. et sp. n. (Plate XXVIII. figs. 8-10.)

The collection consisted of about a dozen specimens, all of which were mature, and measured 3.5-4.6 mm. in length. The body is elongated, slightly flattened and of fairly uniform breadth. The greatest breadth occurs about the middle and is 1-1.4 mm. The length is therefore about $3\frac{1}{2}$ times the breadth. The cuticle is beset throughout its whole extent by long straight spines. It appears to be somewhat deciduous, and in many specimens is absent from a considerable part of the body, especially towards the posterior end. Several specimens, however, retained the cuticle and spines quite intact.

In a specimen of average length (4.2 mm.) the oral sucker measures .56 mm. in diameter. It is globular, almost terminal and not very muscular. The ventral sucker is practically of equal size, if anything a trifle less. It is somewhat transversely oval, the dimensions being $.52 \times .57$ mm. It is only slightly prominent,

not very muscular, and is situated 1.7 mm. from the anterior end. The neck, therefore, comprises $\frac{2}{3}$ of the body-length.

The alimentary canal is highly developed. It consists of a very short prepharynx, with an enormous pharynx measuring .28 mm. in diameter. The œsophagus is shorter than the pharynx, being only about .2 mm. long. It is fairly wide, with well-developed musculature and numerous peri-œsophageal cells. It divides into two very wide diverticula, which extend along the sides of the body to near the posterior end. From the latter they are separated by a loop of the uterus. The ends are slightly inflated and somewhat turned in.

The excretory system has the same general structure as in the two previous species. The main stem of the excretory vesicle divides close behind the shell-gland into two limbs, which extend a short distance in front of the ventral sucker. From the vesicle numerous twigs are given off, which divide and subdivide in the lateral fields to form an intricate anastomosis. The most peculiar feature of the excretory system, however, is the pigmented condition of the excretory tubules, which renders them strikingly conspicuous and marks out their course with great distinctness. This feature renders the species unique amongst the Lepodermatidæ. The pigmentation is due to the excretory granules, which are almost black in colour, and which fill the tubules. Only a few of these are to be met with in the vesicle. A main excretory tubule runs along the greater part of the length on each side of the body, ventral to the intestinal diverticula. In front of the ventral sucker it divides into small branches, one of which runs in to join the vesicle, and another runs forward to the oral sucker. At the posterior end it also divides into several branches. It is impossible to say whether this pigmented condition occurs in life or is a post-mortem appearance, but it was certainly present in all the specimens.

The genital aperture is median, just over the intestinal bifurcation (.3 mm. in front of the ventral sucker). It shows a tendency to be deflected very slightly to the left side. In every specimen the long, thick cirrus was exerted. The cirrus-pouch is short and stout, in some cases being almost globular. Its posterior end lies dorsal to the middle of the ventral sucker, but it may extend beyond this to almost the posterior border of the sucker. The pouch has an external wall composed of very thick longitudinal muscle-fibres, with an inner layer of much smaller circular fibres. It contains a small, slightly-coiled vesicula seminalis, a small bulbous pars prostatica, with numerous prostatic cells, and a long ductus and unarmed cirrus. As already mentioned, the latter was exerted in every case, so that the arrangement depicted in fig. 8 (Pl. XXVIII.) must be regarded as hypothetical. The vesicula, prostate, and cirrus all have a very well-marked layer of longitudinal muscle-fibres.

The testes are situated obliquely, the left being well in front of the right, but not entirely so. The former lies about .3 mm., and the latter .8 mm. behind the ventral sucker. They are large ovoid

bodies, with entire margins, and their long axes lie nearly in the longitudinal axis of the body. They measure $\cdot 5$ – $\cdot 7$ mm. in length and $\cdot 4$ – $\cdot 5$ mm. in breadth. They are most remarkable, however, for their great thickness, which is equal to or greater than the breadth. They thus occupy nearly the whole body-thickness, a fact which prevents them being obscured by the uterus. They are separated from each other by the wide ascending limb of the uterus, against which they press, and their outer margins are closely apposed to the intestinal diverticula.

The ovary is situated over the right posterior quadrant of the ventral sucker, a short distance behind the end of the cirrus-pouch. It projects well beyond the sucker, and is transversely oval, measuring $\cdot 35$ mm. \times $\cdot 28$ mm. It lies close up to the dorsal surface of the body. Close to the inner side of the ovary and a little behind it, lies a large shell-gland, with a short ootype. A receptaculum seminis is absent, but Laurer's canal is present. The yolk-glands are rather voluminous. They are entirely lateral and peripheral, and they extend from the level of the genital aperture, or rather behind it, to near the posterior border of the right testis. Here, again, the anterior limit is fairly constant, but the posterior limit is somewhat variable, less so, however, than in the two species already described. The follicles are large and arranged in regular dendritic groups. All the follicles are connected up by short ducts. They lie close under the surface of the body, extending widely under the dorsal surface, but being much more restricted ventrally, where they do not overlap the inner wall of the intestinal diverticula.

The uterus is large and voluminous, but is not much convoluted. It is intermediate in type between that of *Renifer* and *Ochetosoma*, but resembling the former more than the latter. It consists of a small descending limb, which has a dorsal position and contains a considerable number of ova. This runs to the posterior end of the body where it forms a small convoluted knot, a fairly symmetrical pair of loops, one on each side, being thrown up towards the ends of the intestinal diverticula. From this knot emerges the ascending limb, which rapidly widens but does not attain its maximum width till it has passed in front of the testes. It is never so enormously dilated as in *Lechriorchis validus*. Near the middle of the ventral sucker it runs into a remarkably powerful vagina, which is as long as or somewhat longer than the cirrus-pouch. The vagina possesses unusually muscular walls, there being a very thick layer of longitudinal fibres and an equally thick layer of circular fibres. It is surrounded by a great mass of peri-vaginal cells, and it is lined by a thick layer of cuticle from which small regular cuticular processes extend into the lumen. The ova are numerous, dark brown and oval, with large well-marked operculum. They measure $\cdot 033$ – $\cdot 037$ mm. in length and $\cdot 016$ – $\cdot 019$ mm. in breadth, the usual size being $\cdot 036 \times \cdot 018$ mm.

The genus *Dasymetra* may be defined as follows:—

Lepodermatidæ; with moderately flattened body, entirely covered
PROC. ZOOLOG. SOC.—1911, No. XLVIII.

with spines. Intestine with large pharynx and wide diverticula which extend near but not quite to the posterior end. Excretory vesicle Y-shaped with numerous side twigs. Genital aperture median, a short distance in front of the ventral sucker. Cirrus-pouch short and plump; vesicula and pars prostatica short; cirrus long. Receptaculum seminis absent; Laurer's canal present. Yolk-glands extensive, dendritic, peripheral. Uterus forming a small convoluted knot at the posterior end of the body, with a wide unconvoluted ascending limb. Vagina long and very muscular. Ova about .035 mm. long.

Type, *D. conferta*, sp. n.

The type-specimens of these species are deposited in the Museum of the Royal College of Surgeons, London. Co-types at the Zoological Society's Gardens.

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- (4) H. S. PRATT, 1903.—Descriptions of Four Distomes. Mark Anniversary Volume, pp. 23–38.
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EXPLANATION OF THE PLATES.

The following letters apply to all the figures:—

<i>D.St.</i> Yolk-glands.	<i>R.S.Ut.</i> Receptaculum seminis
<i>Ex.</i> Excretory vesicle.	uterinum.
<i>Ex.T.</i> Excretory tubules.	<i>T., T₁, T₂.</i> Testes.
<i>J.</i> Intestinal diverticula.	<i>Ut.</i> Uterus.
<i>K.St.</i> Ovary.	<i>Vg.</i> Vagina.
<i>P.Pr.</i> Pars prostatica.	<i>V.S.</i> Vesicula seminalis.

PLATE XXVII.

Lechriorchis validus.

- Fig. 1. Young specimen. Ventral view. $\times 25$.
2. Adult specimen. Ventral view. $\times 20$.
3. Transverse section near ends of intestinal diverticula. $\times 53$.
4. Transverse section, immediately in front of ventral sucker. $\times 50$.
5. Ovum. $\times 500$.

PLATE XXVIII.

Ochetosoma formosum.

- Fig. 6. Ventral view. $\times 30$.
7. Ovum. $\times 550$.

Dasymetra conferta.

- Fig. 8. Ventral view. $\times 30$.
9. Transverse section, a little in front of ventral sucker. $\times 60$.
10. Ovum. $\times 500$.



H. Goodchild del et lith.

Huth imp.

THE CHINESE TAKIN,
BUDORCAS BEDFORDI.

32. The Duke of Bedford's Zoological Exploration of Eastern Asia.—XIV. On Mammals from Southern Shen-si, Central China. By OLDFIELD THOMAS, F.R.S., F.Z.S.*

[Received and Read April 25, 1911.]

(Plate XXIX. †)

As already indicated in paper No. XIII. of the present series ‡, Mr. Malcolm Anderson and his party, working on behalf of the Duke of Bedford, obtained a considerable number of mammals in Southern Shen-si before going on to Kan-su and Sze-chwan, whence the series described in that paper was collected. Owing to delay in transport, however, a large part of the Shen-si collection has only recently arrived, and the diagnoses of *Myotis myosotis ancilla*, *Microtus nux* and *M. johannes* § are all that have been published upon it.

The present paper gives a list of all the specimens obtained in S. Shen-si by Mr. Anderson between his second landing in China in the autumn of 1909 and his move on into Kansu in 1910.

The regions explored were, firstly, the district round Shang-chou, S.E. Shen-si (about 33° 40' N., 110° 20' E.), and, secondly, the important mountain Tai-pei-san (about 34° N., 107° 30' E.), one of the sacred Chinese mountains, another being Omi-san, Sze-chwan, where at a later period Mr. Anderson obtained the many new species described in my Sze-chwan paper.

Of the majority of the Shen-si specimens there is little new to record, as Mr. Anderson had obtained the same species on his previous visit to the more northern part of the province. But in any case their interest is dwarfed by the discovery on Tai-pei-san of a magnificent species of Takin, quite different from the known W. Chinese species *Budorcas tibetanus*, and both in interest and beauty one of the most striking [mammals that it has ever been my good fortune to describe.

Besides this fine animal, of which a coloured figure is given (Pl. XXIX.), Mr. Anderson obtained a new Badger, a new Pika, and a new Vole ||.

1. RHINOLOPHUS FERRUM-EQUINUM Schreb.

♀. 2079, 2080, 2081. Shang-chou District, S.E. Shen-si.

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† For explanation of the Plate see p. 695.

‡ P. Z. S. 1911, p. 158.

§ P. Z. S. 1910, p. 635.

|| The complete account of these new forms appears here, but the names and preliminary diagnoses of the species underlined were published in the 'Abstract,' No. 95, 1911.—EDITOR.

2. MYOTIS MYOSOTIS ANCILLA Thos.

♂. 2082, 2083, 2084. ♀. 2085. Shang-chou Dist., S.E. Shen-si.

The typical series (*cf.* P.Z.S. 1910, p. 636), no. 2082 (B.M. No. 10.5.2.4.) the type.

3. CROCIDURA ATTENUATA M.-Edw.

♂. 2009. King-tze-Kwan, S.W. Honan. 850'.

4. CROCIDURA COREÆ Thos.

♂. 2185. 30 miles S. of Feng-hsiang-fu, S. Shen-si. 7000'.

5. FELIS FONTANIERI M.-Edw.

♀. 2038. Shang-chou District, S.E. Shen-si. 3000'.

This fine Leopard is a valuable accession to the Museum collections.

6. FELIS MICROTIS M.-Edw.

♂. 2176. 30 miles S. of Feng-hsiang-fu, S. Shen-si. 3600'.

7. VIVERRA ZIBETHA, subsp. ?

2192. Native skin. 40 miles N. of Han-chung-fu, Shen-si.

This specimen does not agree with the description of the Civet called *V. filchneri* by Matschie, but how far the colour-characters used by him are likely to be diagnostic in so variable a group I am not at present prepared to say.

8. PAGUMA LARVATA Gray.

♂. 2053. Shang-chou Dist., S.E. Shen-si. 2300'.

9. VULPES sp.

♂. 2178. 30 miles S. of Feng-hsiang-fu, S. Shen-si. 3600'.

10. LUTREOLA SIBIRICA Pall.

♂. 2070. Shang-chou Dist., S.E. Shen-si.

♀. 2118. Si-ngan-fu, Shen-si. 1200'.

11. ARCTONYX LEUCOLEMUS ORESTES.

Thos. Abstr. P. Z. S. 1911, p. 27 (May 2).

♀. 2191 (young adult). Tsin-ling Mts., 34° N., 107° 45' E., S.W. Shen-si. Alt. 12,000'. 25 January, 1910. B.M. No. 11.6.1.6. *Type.*

Distinguished from the true *leucolemus* of Peking by the following characters:—

Dark mark enclosing eye not broadly projected forwards and downwards to the upper lip, but practically confined to a strong spectacle-mark, barely half an inch broad, surrounding the eye; a narrow and indistinct line only running forwards to the base of the whiskers, the upper lips quite white. Dark patch behind mouth much reduced, a trace only of it running forward to the

angle of the mouth, separated from its fellow of the opposite side by a white interramial space over an inch broad. Light throat-patch not really white, but brownish white, figured in *leucolæmus* as snowy white. Light patch in front of ear less prominent, continuous with but darker than that under the eye. White ear-rim much broader and more prominent. Back more broadly washed with whitish than appears to be the case in *leucolæmus*, the dorsal hairs white for their terminal 15–20 mm., while only their points are said to be white in *leucolæmus*. Tail wholly white.

Dimensions of the type, measured in the flesh :—

Head and body 570 mm.; tail 195; hind foot 94; ear 45.

Skull: condylo-basal length 132 mm.; basal length 123; greatest breadth 72; interorbital breadth 29; palatal length 86; greatest diameter of m¹ 16.

Hab. and *type* as above.

The British Museum had previously possessed no examples of the N. Chinese *Arctonyx*, so that this fine specimen is a valuable accession. On account of the differences above detailed I cannot refer it to the true *leucolæmus*, but think it represents a special subspecies, as is the case with so many other Shen-si mammals.

12. *PETAURISTA ALBORUFUS* * M.-Edw.

2194. Native skin. Near Pao-Ning-Fu, N. Sze-chwan.

13. *TROGOPTERUS XANTHIPES* M.-Edw.

2055. Shang-chou Dist., S.E. Shen-si.

14. *SCIUROTAMIAS DAVIDIANUS* M.-Edw.

♂. 2022, 2037, 2052, 2065, 2066, 2067, 2069, 2087, 2095, 2104. ♀. 2054, 2059, 2096, 2105. Shang-chou Dist., S.E. Shen-si.

♂. 2106, 2115. Ching-ling Mts., Lo-nan-hsien, S. Shen-si.

♀. 2107. Ching-ling Mts., Lo-nan-hsien, S. Shen-si.

15. *EPIMYS CONFUCIANUS*, subsp.

♂. 2034, 2063, 2064. ♀. 2024, 2033, 2035, 2036, 2039. Shang-chou Dist., S.E. Shen-si.

♂. 2114. Ching-ling Mts., Lo-nan-hsien, S. Shen-si.

♀. 2100. King-tze-Kwan, S.W. Honan.

♂. 2012, 2014. ♀. 2015, 2016. Shan-nan-hsien, S.E. Shen-si.

♂. 2122, 2123, 2137, 2140, 2143, 2144, 2152, 2161. ♀. 2162. 30 miles S. of Feng-hsiang-fu. 3600'.

In my previous paper the Kan-su specimens of this group were assigned to *E. confucianus luticolor*, though tending to intergrade with the typical *E. confucianus* of Sze-chwan. But now, on laying out the whole of the N. China representatives of the group,

* *Petaurista* is masculine, this being one of the numerous names which by their deceptive form render desirable the suggested convention that all generic names in zoology should be treated as masculine. See Stebbing, 'Knowledge,' xxxiii. p. 259, 1910.

I find that the true *E. c. luticolor* is a pale desert form peculiar to the region towards the Ordos desert, that the present S. Shen-si specimens are, as is geographically correct, intermediates between the *E. c. sacer* of Shantung on the east and the Kan-su form on the west, and that the latter is sufficiently differentiated to have a special subspecific name of its own. It may be called

EPIMYS CONFUCIANUS CANORUS, subsp. n.

General colour approximating to "clay-colour," slightly darker and more tawny than in *sacer*, much darker than in *luticolor*, lighter than in *confucianus*. Median darker dorsal line averaging more distinct than in *confucianus*, less than in *sacer*. White of under surface more markedly tinged with buffy or cream-colour than in the other subspecies (but there is a doubt as to how much this fades after death). Metatarsals without, or with but slightly marked, darker patches. Tail with the dark colour of its upper surface passing nearly or quite continuously to the end; its tip hardly so heavily tufted as in *sacer*.

Skull about as in *confucianus* and *luticolor*, smaller than in *sacer*.

Dimensions of the type, measured in the flesh:—

Head and body 120 mm.; tail 180; hind foot 27; ear 21.5.

Skull: greatest length 34.5 mm.; condylo-incisive length 30.5; upper molar series 6.

Hab. Southern Kan-su, grading eastwards into *sacer* and southwards into true *confucianus*. Type from Wen-hsien Country, S. Kan-su.

Type. Adult female. B.M. No. 11.2.1.110. Original number 2282. Collected 6 May, 1910.

16. *MUS WAGNERI* Eversm.

♂. 2094. Shang-chou Dist., S.E. Shen-si.

17. *APODEMUS SPECIOSUS PENINSULÆ* Thos.

♂. 2046, 2076, 2077. ♀. 2045, 2047, 2092, 2093, 2103. Shang-chou Dist., S.E. Shen-si.

♂. 2113. Ching-ling Mts., Lo-nan-hsien, S. Shen-si.

♀. 2126, 2132, 2136. 30 miles S. of Feng-hsiang-fu, S. Shen-si.

♂. 2167, 2169, 2172. ♀. 2166, 2168, 2174. Tai-peï-san. 10,600'.

18. *APODEMUS AGRARIUS PALLIDIOR* Thos.

♂. 2030. ♀. 2031, 2040, 2057, 2058, 2061. Shang-chou Dist., S.E. Shen-si.

♂. 2019. ♀. 2020. Shan-nan-hsien, S.E. Shen-si.

♀. 2108, 2109, 2112. Ching-ling Mts., Lo-nan-hsien, S. Shen-si.

9 ♂, 9 ♀. 30 miles S. of Feng-siang-fu, S. Shen-si. 3600'.

19. *MICROMYS MINUTUS* M.-Edw.

♂. 2056. Shang-chou Dist., S.E. Shen-si.

20. *CRICETULUS TRITON* Thos.

♀. 2011. King-tze-Kwan, S.W. Honan.

♂. 2013, 2018. Shan-nan-hsien, S.E. Shen-si.

♀. 2028, 2029, 2062. Shang-chou Dist., S.E. Shen-si.

21. *CRICETULUS ANDERSONI* Thos.

♂. 2116, 2117. Si-ngan-fu, S. Shen-si. 1200'.

22. *MICROTUS CALAMORUM SUPERUS*.

Thos. Abstr. P. Z. S. 1911, p. 27 (May 2).

♂. 2121, 2127, 2128, 2129, 2138, 2139, 2147, 2154, 2163, 2181, 2182, 2183.

♀. 2119, 2120, 2130, 2146, 2155, 2164, 2179, 2180. 30 miles S. of Feng-hsiang-fu, S. Shen-si. 3600'.

A larger longer-tailed race of the Nanking Vole.

Fur longer and finer than in true *calamorum*, the hairs of the back about 16 instead of 10 mm. in length. Colour quite as in *calamorum*, except that all the specimens have a dull buffy suffusion in the surface-colour of the abdomen, this being only the case in certain of the younger examples of *calamorum*, the older ones having the belly clear greyish white. Tail longer than in *calamorum*, the usual length in adult specimens 60–63 mm., as against 52–53 in that animal, its coloration more prominently bicolor.

Skull like that of *calamorum*, but slightly longer than in specimens of similar age. Nasals longer. Bullæ generally larger.

Dimensions of the type, measured in the flesh:—

Head and body 130 mm.; tail 63; hind foot 24; ear 13.

Skull: condylo-basal length 33 mm.; condylo-incisive length 33.2; zygomatic breadth 17.8; nasals 8.5×3.6 .

Type. Adult male. B.M. No. 11.6.1.45. Original number 2163. Collected 7 January, 1910.

This Shen-si representative of the Lower Yang-tze Reed-Vole is distinguishable by its longer tail and longer fur, the latter in obvious correlation with the greater altitude at which it is found.

23. *MICROTUS MANDARINUS* M.-Edw.

♀. 2032. Shang-chou Dist., S.E. Shen-si.

Skull. S.E. Shen-si.

The specimens referred to in the description of *Microtus johannes* (P. Z. S. 1910, p. 637).

24. *MICROTUS (CARYOMYS) NUX* Thos.

♂. 2041, 2042, 2043, 2072, 2073, 2088, 2089, 2090, 2097, 2098. ♀. 2044, 2050, 2091, 2100. Shang-chou Dist., S.E. Shen-si.

♂. 2110, 2111. Ching-ling Mts., Lo-nan-hsien, S. Shen-si.

Described from these specimens, P. Z. S. 1910, p. 636. No. 2089 (B.M. No. 10.5.2.79) the type.

25. *MICROTUS* (*CARYOMYS*) *EVA* Thos.

♂. 2173. Tai-pei-san, Tsin-ling Mts., S.W. Shen-si. 10,600'.

The typical series was obtained near Tai-chow, Kan-su, at a similar elevation.

26. *LEPUS* *SWINHOEI* Thos.

♂. 2145. 30 miles S. of Feng-hsiang-fu, S. Shen-si. 3600'.

Represents *L. filchneri* Matsch., and also the Tai-pei-san subspecies "suppressed" by Dr. Allen*, to which he, nevertheless, attaches the name *L. swinhoei brevinasus*.

Of all the many examples of *L. swinhoei* obtained by Mr. Anderson, whether topotypes from Shantung or from other localities, this specimen is one of those that agree most closely with the type collected by Swinhoe, owing to its being a dark-coloured individual, with its general buffy coloration more or less suffused with pinkish.

27. *OGOTONA* *SYRINX*.

Thos. Abstr. P. Z. S. 1911, p. 27 (May 2).

♂. 2170. ♀. 2171. Tai-pei-san. 10,600'.

(?) ♂. 2071 (young). Shang-chou Dist., S.E. Shen-si. 3300'.

Related to *O. cansa*, but larger. Bullæ smaller.

Size distinctly larger than in *O. cansa* and *O. sorella*. Fur (in winter pelage) long and soft, not very thick; hairs of back about 16-17 mm. in length. General colour more blue-grey throughout than in *cansa*; head grey tinged with clay-colour; nape "smoke-grey"; dorsal area darker grey tinged with brown; rump nearly "mouse-grey." Flanks near "broccoli-brown." Under surface greyish, the bases of the hairs slaty, their tips greyish white. Ears greyish brown, their proectotæ blackish, their rims white; the tuft of long hairs at their inner base nearly "cinnamon." Hands and feet white above, the thickly haired palms and soles "smoke-grey."

Skull of the same general type as in *O. cansa*, of similar flattened form, the palatal foramina not subdivided. Size distinctly greater throughout; nasals of about the same shape, not narrowed as in *O. sorella*. Interorbital space and brain-case broader. Bullæ conspicuously smaller or at least lower, those of *O. cansa* being very large for so small a species.

Dimensions of the type, measured in the flesh:—

Head and body 142 mm.; hind foot 28.5; ear 16.

Skull: greatest length 36.5 mm.; condylo-incisive length 33.5; zygomatic breadth 18.5; nasals 11.8 × 5.4; interorbital breadth 4.3; breadth of brain-case 15.7; palatilar length 12; palatal foramina 9.2 × 3.7; upper cheek-tooth series (alveoli) 7.1.

Hab. Tai-pei-san.

* Bull. Am. Mus. N. H. xxvi. p. 427, 1909.

Type. Adult male. B.M. No. 11.6.1.59. Original number 2170. Collected 9 January, 1910.

This is probably the species recorded as *O. cansa* by Dr. Allen *, who had, however, only "skins with fragmentary skulls" for comparison with the single type of Dr. Lyon's species. The present perfect specimens, compared with the topotypical series of *O. cansa* obtained in Kan-su by Mr. Anderson, show that the species is readily distinguishable, both by its greater general size and its much less swollen bullæ.

No. 2071 is too young for certain determination, but it is interesting as still retaining in place the minute milk-predecessors of the small posterior incisors. The milk-teeth are pressed close against the front face of the permanent teeth, between these and the large incisors in front of them.

28. *Sus* sp.

♀. 2186. 30 miles S. of Feng-hsiang-fu, S. Shen-si.

In the state of confusion to which the late Père Heude reduced the systematic arrangement of the Chinese members of *Sus*, as with every other genus with which he dealt at any length, it is impossible to give a satisfactory determination of this Wild Boar at present. It probably represents the *Sus oxyodontus* of Heude, from the Upper Han, but whether that is or is not a valid species I am unable to express an opinion.

29. *BUDORCAS BEDFORDI*. (Plate XXIX.)

Thos. Abstr. P. Z. S. 1911, p. 27 (May 2).

♂. 2175. ♀. 2189, 2190. Tai-pei-san. 10,000'.

A wholly pale buffy species, practically without darker markings.

Fur longer and richer than in the available specimens of *B. tibetanus*, but the dates of these are not known, while the examples of *B. bedfordi* were killed in mid-winter; hairs of sides of neck attaining 7-8 inches, and those of back 3-4. General colour a beautiful glossy golden-buffy, more cream-buff in the females, more tending towards ochraceous in the male; at least at the ends of the hairs, their bases being still creamy or whitish. Darker markings on muzzle, ears, hinder back, and limbs, characteristic of *B. tibetanus*, practically absent. No. 2190 (♀) entirely without darker hairs on the muzzle, 2175 (♂) with a few, and 2189 (♀) with more, but the inconspicuous darker patch so formed very different from the large and prominent black mask characteristic of *B. tibetanus*. Dorsal line not darkened at all, its hairs elongated and more strongly buffy in the male, not differentiated at all in the females. Limbs not obviously darkened terminally, though a few isolated darker hairs are present on the carpus and tarsus.

* Bull. Am. Mus. N. H. xxvi. p. 427, 1909.

Tail bushy, a few darker hairs on it in No. 2189, soiled ochraceous buffy in the others.

Skull apparently rather smaller, and its nasal region less vaulted than in either *taxicolor* or *tibetanus*, but, owing to differences in the ages of the specimens available, a satisfactory comparison is not at present possible.

Dimensions of the male, measured by Mr. Anderson in the flesh :—

Head and body 1925 mm. ; tail 23 ; hind foot 340 ; ear 127.

Skulls :—

	♂ (young adult).	♀ (adult).
Condyllo-basal length	389 mm.	381 mm.
Zygomatic breadth	176	164
Height of nasal convexity above middle of palate.....	118	113
Length of muzzle, to front of p ²	113	115
Palatal length	245	241
Greatest spread of horns, on outer edge...	401	308

Type. Adult female. B.M. No. 11.6.1.64. Original number 2190. Killed 15 January, 1910.

The discovery of this splendid animal, whose golden-buffy colour renders it by far the most beautiful of its genus, is of the highest interest, and it is with great pleasure that I name the species in honour of the Society's President, during whose exploration of Eastern Asia it has been obtained. Mr. Anderson himself seems to have thought the occurrence of Takin on Tai-pei-san of special interest, and believed that they would probably prove to be new. He says : " The herds on Tai-pei-san are isolated by some hundreds of miles from the nearest others we could hear of, and as I could not learn that any other foreigner has hunted them on Tai-pei, I believe the chance for a new species is good."

As a matter of fact, however, specimens had previously been obtained and had passed into the possession of the American Museum of Natural History at New York. But these were quite young, and showed, as it was not unnatural that the young should show, more or less of the normal coloration of the group, with blackish muzzle and extremities, and therefore in recording them Dr. Allen* saw no reason to suppose them different from *B. tibetanus*. The practically unicolor condition of *B. bedfordi* proves therefore to be a characteristic of the adult, a fact which, in view of the peculiar specialization of such a colour, is not at all surprising.

Even in *B. tibetanus*, as shown by Milne-Edwards's figure†, the young is very materially darker than the adult.

That the Takin of Tai-pei-san and other parts of the Pe-ling range should be different from that of the mountains of Sze-chwan

* Bull. Am. Mus. N. H. xxvi. p. 425, 1909.

† Rech. Mamm. Atl. pl. 74.

is only in accordance with the indications furnished by the remainder of Mr. Anderson's collections, as brought out in the paper No. XIII. of the present series*.

With regard to other names that have been given in the genus *Budorcas*, Mr. Lydekker† has shown that both *sinensis* and *mitchelli* are synonymous with *tibetanus*, so that there appears to be no existing name which comes into question in now describing this beautiful species.

It may be noted that on each side of the withers of the two females there is a large patch of grey hairs, these hairs being horny whitish, curiously ringed or beaded with black. Similar hairs have been found on a specimen of *B. tibetanus*, and so would appear to be natural and not discoloured artificially as I at first supposed. No such patch is present on the male.

Mr. Anderson has sent me the following further notes on this animal:—

“Takin.—Found in large herds on Tai-pei-san, where it lives in precipitous places at from 9,000 to 11,000 ft. altitude. Its food is bamboo grass; a small bamboo very common at these altitudes. Although apparently clumsy, I found these animals very alert, and capable of picking their way very deftly and rapidly down steep mountain sides. A herd my companions and I saw seemed to contain about 40 individuals; Chinese hunters reported another herd of 80. These herds seem quite isolated on the peaks of Tai-pei-san. Travelling westward we did not hear of any Takins again till we reached Pie-kou in Southern Kansu, and I am in doubt whether this was the same animal or not.

Chinese name:—Pan-yang; at Tai-pei. The species in Szechwan is called Yei-nu=Wild Cow. The name Pan-yang is also applied to a mountain sheep or goat.”

30. *NEMORHÆDUS* sp.

♀. 2188. 30 miles S. of Feng-hsiang-fu, S. Shen-si. 10,000'.
Near the Long-tailed Goral (*N. caudatus* M.-Edw.).

31. *CAPREOLUS BEDFORDI* THOS.

♂. 2153 (young). ♀. 2177, 2187. 30 miles S. of Feng-hsiang-fu. 3600'.

EXPLANATION OF PLATE XXIX.

The Chinese Takin (*Budorcas bedfordi*). Male.

* P. Z. S. 1911, p. 158.

† P. Z. S. 1908, p. 795.

EXHIBITIONS AND NOTICES.

May 9, 1911.

E. G. B. MEADE-WALDO, Esq., Vice-President,
in the Chair.

Mr. R. I. Pocock, F.R.S., F.L.S., Superintendent of the Gardens, exhibited some of the hair of the "puppy coat" of a Grey Seal (*Halichærus grypus*), which was caught at Barmouth, in Merionethshire, at the end of April. When received at the Gardens at the beginning of May this Seal was covered, with exception of the head and flippers, with longish woolly white hair, the last of which was moulted on May 7th. Most authorities state that Grey Seals are born in the autumn, not later than about the middle of October, and that the puppy coat is shed from a month to six weeks later. Allowing six weeks for the retention of its puppy coat, this Welsh Grey Seal must have been born near the middle of March, a date in tolerably close agreement with the date, namely the end of February, given by Cneiff for the birth of these Seals in the Gulf of Bothnia. It is, therefore, quite clear that these Seals breed both in the early spring and the autumn.

Mr. E. G. BOULENGER exhibited some living male specimens of the Midwife Toad (*Alytes obstetricans*) carrying the eggs. He also exhibited a number of the detached eggs to show the manner in which they were strung together.

Mr. A. E. ANDERSON exhibited a large number of photographs of the more important fossil mammals in the Department of Vertebrate Paleontology of the American Museum of Natural History, New York, showing the methods of mounting fossil skeletons. For comparison, a set of photographs was exhibited with the skeleton supports eliminated from view, thus adding to the pictorial value of pose in the specimens.

PAPERS.

33. An Investigation into the Validity of Müllerian and other forms of Mimicry, with special reference to the Islands of Bourbon, Mauritius, and Ceylon. By NEVILLE MANDERS, Lieut.-Colonel, R.A.M.C., F.Z.S., F.E.S.

[Received May 8, 1911: Read May 9, 1911.]

Naturalists generally and the majority of entomologists are disposed to accept a broad view that mimicry is caused by

natural selection, but beyond this some are not prepared to go. Others believe more or less implicitly in cryptic mimicry, either active or passive, and that peculiar form of it known as Batesian mimicry, that is, the resemblance for protection of a palatable to an unpalatable species. And there are others again who, believing in these, consider that Müllerian mimicry, that is, the resemblance of unpalatable species for mutual protection brought about by the tasting experiments of young reptiles and birds, plays a very large part, even an overwhelming one, in the production of mimicry.

The theories of the two great naturalists Bates and Müller have now been before us for a great number of years; but both, the latter more especially, base their claims to recognition on indirect evidence and not on experiments and investigation in the field. The exponents of these two theories maintain that though direct evidence is largely absent, yet on no other reasonable hypothesis can these remarkable cases of mimicry be explained. The opponents, on the other hand, hold the view that as direct evidence is possible though admittedly difficult to obtain, it ought to be produced before either theory can be admitted as proved, and until it is forthcoming they remain either actively hostile or passively sceptical. It was with the feeling that both the supporters of these theories and those opposed to them were equally desirous of reaching some finality in this vexed question, which has now been before them in one form or other for half a century—a question which, with its periodical exhibition of violent eruption and deceptive quiescence much resembles an Iceland geyser—that I have during the past five years devoted as much of my time as was practicable to the study of insectivorous birds and reptiles; and I have taken as my areas of investigation the islands of Bourbon, Mauritius, and Ceylon, because the question is less complicated on an island of small or moderate dimensions than on such an extensive area as Africa or South America.

Before I left England in 1908 I had the great advantage of being taken over the National Collection of Butterflies by Mr. Guy Marshall, who, with his unrivalled knowledge of the subject and persuasive powers, almost then and there made me throw in my lot with the supporters of the Müllerian theory, but in the midst of his arguments recollections of scenes in tropical jungles obtruded themselves, and I was left in an irritating condition of mingled belief and incredulity. A fairly extensive reading of the whole subject consequently did little to convince me, and my personal bearing towards both Batesian and Müllerian mimicry was that the verdict must be the unsatisfactory one of “not proven.”

I propose taking each of the islands in turn, enumerating the reptiles and birds with their habits and distribution, directing attention to the more striking cases of mimicry, and endeavouring to ascertain on such data how far these theories are negatived or sustained.

BOURBON.

Bourbon is a small circular island less than forty miles in diameter, lying some three hundred miles from the east coast of Madagascar. It has only twenty-two species of butterflies and certainly one case of mimicry, which is very striking and quite peculiar. It is that of a female *Papilio* (*phorbanta*) resembling a *Euplœa*. The group to which this *Papilio* belongs is green in both sexes, but in this insect the female is dark brown and resembles more or less closely the brown *Euplœa* (*goudoti*) occurring in the island. There is no occasion to go into details, as I have already brought them to the notice of the Entomological Society in its Proceedings and Transactions, 1908, and have figured both butterflies; but I may add that they are essentially insects of the littoral, common on one small portion of the coast, particularly in gardens on the outskirts of St. Denis, but very rarely found above 1,500 feet or 2,000 feet. They are generally associated.

Bourbon has no lizards with the exception of one introduced species which is very rare. I was fortunate enough to find a specimen; and I should say, judging by somewhat similar Ceylon lizards, that in all probability butterflies would form part of its diet, but it is far too rare to have any marked effect on the butterfly population.

The following is a list of the insectivorous birds given to me by a resident naturalist, which, so far as my knowledge extends, is complete:—

1. The Sparrow. *Passer domesticus*.
2. The Mynah. *Acridotheres tristis*.
3. *Zosterops* (*Malacirops*) *borbonica*.
4. *Zosterops hæsitata*.
5. Bec-Bec. *Pratincola* (*Motacilla*) *sybilla*.
6. Coq des bois. *Trochocercus borbonicus*.
7. The Wheat Swallow. *Phedina borbonica*.
8. The Little Grey-rumped Swiftlet. *Collocalia francica*.
9. Le Merle cuisinier. *Lalage* (*Oxynotus*) *newtoni*.

With regard to these, two, the Sparrow and Mynah, have been introduced; on the former I need make no remark, it has the same habits as its English relations. Two efforts have been made in the last hundred years to instal the Mynah, but without success, and this because it is considered a desirable morsel by the natives and is mercilessly trapped and consequently very scarce; I saw only one pair during my stay in the country.

Both species of *Zosterops* are very small birds, no bigger than the English wren, and are found either singly or in small family parties of five or six, flitting and creeping about the shrubs after the manner of our long-tailed tits; they feed on nectar and small insects. The *Motacilla* or Chat is of the same size and much the same colouring as the Whinchat, and quite possibly feeds

on the smaller butterflies, but would scarcely tackle an insect considerably larger than our Swallowtail, but of this I have no evidence. I saw it frequently in the gorge leading up to Salazie and on the hills round St. Denis, but I saw nothing of it in the neighbourhood of the town.

The Flycatcher (*Trochocercus borbonicus*) is the same species as occurs in Mauritius; it is said, on the authority of M. de Charmoy, to feed on diptera and by preference on mosquitoes. It is quite a small bird.

The Wheat Swallow (*Phedina borbonica*) has precisely the same habits as regards its food as the English species; it appeared to me to be fairly plentiful. It also occurs in Mauritius.

The Little Grey-rumped Swiftlet (*Collocalia francica*) is the well-known species that forms a nest of inspissated saliva. It occurs in Mauritius. It is quite a small bird, decidedly smaller than our Sand-Martin, and may occasionally snap up a small Lycaenid.

Le Merle cuisinier, or Tui-tui — *Lalage* (*Oxymotus*) *newtoni*. I am unable to say whether this bird is abundant or not, or whether it destroys butterflies. I did not come across it in Bourbon, so I am inclined to doubt its being particularly common. It has the same habits as the Mauritius *Lalage rufiventris*.

In the absence of any living bird it occurred to me that possibly the extinct Bourbon Starling might have been the prime factor in producing this case of mimicry, and I therefore wrote to my venerable friend Dr. Jacob de Cortimoy for information concerning it. He is now verging on his ninetieth year, and is probably the only one now living who has seen this bird alive; his letter is so interesting that I need make no apology for transcribing a portion of it.

"I have known the bird you ask me about since childhood, namely the *Fregilupus varius* (old writers called it *F. capensis*), which has in fact entirely disappeared When I was a boy this bird lived in the forests of the interior of the island and never set foot nor wing in towns or inhabited places. It remained faithful to the forests where it was bred, which it enlivened with its clear notes. I used to hunt it then at an age when one is pitiless. I can see it now, a little larger than the white black-bird, with a white crest on the head in the case of the male, the wings a blackish grey on the upper surface, the beak and feet yellowish. By no means shy, it was not frightened even by the sound of firearms, and after a regular slaughter one went off with dozens of these poor victims in one's game-bag.

"After ten years spent in Paris I did not find a single one in the forests where formerly they flew about in flocks. All ruthlessly destroyed. I shall never forgive myself for the part, slight though it was, which I took in the matter. I lost my taste for sport and the best bag would not tempt me. We will now consider the feeding habits of this bird. Having raised several in the aviary, I can risk talking about it though I never saw

one feeding in the wild state. In my aviary its food consisted of bananas, potatoes, and choux-choux, *Sechium edule* (boiled). But when left to its own instincts, it must, like the other winged denizens of the forest, have eaten insects as is done by its companion in the forests, the Bourbon Blackbird (*Hypsipetes olivaceus*)*, and as is the habit of most fruit-eating birds."

This is a sad commentary on our boasted civilization, and I have only to add that not half a dozen skins are now in existence.

This bird cannot have been in any way the cause of this mimicry, as it inhabited the forest-covered hills in the interior of the island, where these butterflies do not occur.

Papilio phorbanta female was figured by Boisduval in 1833 and differs in no way from recent specimens. We may therefore infer that the factor or factors which primarily induced this change of colouring are still active; but as there is no reptile or any bird now living which attacks these butterflies as adults, it is difficult to accept this as an effect produced by them. And it would seem that the young of existing birds, with possibly one or two exceptions, would be too small and feeble to attack these large butterflies during their tasting experiments.

I now turn to the island of Mauritius, which lies some eighty miles to the north of Bourbon and which is visible from there on a clear day at certain seasons of the year.

MAURITIUS.

Mauritius has no arboreal lizards, and but one species of ground-lizard, in appearance very like the English Sand-Lizard. It is confined to the coast, and is I believe somewhat uncommon. I found it in some numbers on the uninhabited islet of the Ile de la Passe at the entrance of Mahébourg harbour. It was quite tame, even confidential, and made no display of timidity in taking and eating a small piece of boiled potato presented to it on the end of a fork. We may, I presume, regard this lizard as an indiscriminate feeder!

My friend M. d'Emmerez de Charmoy, Director of the Port Louis Museum, a Mauritius gentleman who has an unrivalled knowledge of the fauna, and who has tracked, shot, skinned, dissected and mounted the whole of the splendid collection of Mauritius birds in the Port Louis Museum, has very kindly favoured me with the following list and notes on the insectivorous birds; it can be taken as complete, and I doubt whether any local fauna of a tropical island is so completely known as is this to M. de Charmoy.

I have added a few notes of my own in square brackets.

1. Le Mangeur de Poule (*Tinnunculus punctatus*) [*Cerchneis punctata*].

Feeds preferably on insects rather than on small birds.

* This bird occurs in Mauritius, but was not given to me by the Curator of the Museum as an insectivorous bird.

I have many times discovered in their stomachs the remains of locusts, field-cricket, and also stick insects.

[This Kestrel is rather smaller than the English bird and, like it, is persecuted persistently. It may also feed on butterflies, but it is so rare that its influence can be little felt; it is entirely confined to the small portion of indigenous forest now remaining.]

2. Le Merle cuisinier (*Oxynotus ferrugineus*) [*Lalage rufigenter*.]

Is essentially insectivorous; I have seen these birds catching *Mantis religiosa* and I have found in their stomachs Scarabæi (*Cratopus*) and fragments of moths' wings.

[This bird of late years has become exceedingly rare and is verging on extinction. On my telling M. de Charmoy that I had seen a pair in the forest, he congratulated me with as much fervour as if I had seen a Dodo !]

3. L'Oiseau Banane (*Foudia erythrocephala*).

Frequents very persistently bananas when in flower, and captures the minute insects which are attracted by the honey of these flowers; lives also on the petals of flowers and on small lepidopterous larvæ. [M. de Charmoy considers from his dissections that this bird is incorrectly placed in this genus, which is essentially a grain-feeding one.]

4. All these species are indigenous and so also are the two species of *Zosterops*, *Z. mauritiana* and *Z. chloronota*, which live almost entirely on the larvæ of lepidoptera. I am unable to give the names of the kinds they capture, but no doubt they take any kind of caterpillar.

5. Le Coq des bois (*Muscipeta borbonica*) [*Trochocercus borbonicus*]. Also indigenous; is an inhabitant of the forests and is found also along river-courses; it chases diptera by preference and particularly mosquitoes.

6. Le Boulbul (*Pycnonotus jocosus*) was introduced in 1892 by M. Gabriel Reynard and is now to be found everywhere. It is certainly to be found in great numbers, being often a plague. It consumes the best fruits and vegetables and the blossoms of fruit trees. I have often seen it hunting for moths, especially for Ophiuridæ, and in the fields of wild indigo it captures Lycænidae. [The most common butterfly in these fields is *Lampides betica*.]

7. Le Martin (*Acridotheres tristis*) was introduced from the Coromandel coast by M. Boucher des Friyes, and by Pierre à Mainard (?) into Réunion, to destroy the crickets which ravaged the islands in 1759. It is found in great numbers in newly tilled fields hunting after all sorts of insects, and especially after the eggs of crickets.

The Fringillidæ cannot be considered insect hunters though they catch one on the wing when they come across it. They

have not the slightest share in the reduction of local species (of insects).

There are thirty species of butterflies, but with the exception of *Hypolimnas misippus* and *Danaïs chrysippus* there is no such well marked case of mimicry as that of the *Euplœa* and *Papilio* in Bourbon.

Professor Poulton has however thrown out the suggestion that the female *Papilio manlius*, though green, is approaching *Euplœa euphon*, as it is of a distinctly brownish green tint compared for instance with the Madagascar *P. epiphorbas*. Mr. Trimen also considers that *Danaïs* (*Amauris*) *phaedon* and the *Euplœa* mimic each other to a certain extent. Instances of seasonal dimorphism (cryptic defence) are however numerous.

The evidence I have collected does not seem to justify the contention that the above instances of mimicry are due to the depredations of old birds or to the experimental tasting of young ones. Though no doubt experimental tasting of insects generally takes place, it would appear that the birds are of such a character that butterflies would not be attacked except to the smallest extent.

CEYLON.

I now turn to the island of Ceylon. If the problem we are considering has so far been simple owing to the small size of the islands dealt with and their very limited fauna, it is by no means so in Ceylon, which is far larger, being about two-thirds the size of Ireland, with a wonderful diversity of hill and plain and equal diversity of climate. Its general characteristics are too well known to require repetition, and there are two hundred and sixty species of butterflies.

Mimicry among Ceylon Butterflies.

Mimicry is by no means uncommon among Ceylon butterflies and the following will serve as examples of it.

MIMIC.	MODEL.
<i>Hypolimnas bolina</i> ♀.	<i>Euplœa</i> (several species).
„ <i>misippus</i> ♀.	<i>Danaïs chrysippus</i> .
<i>Elymnias fraterna</i> ♀.	„ <i>plexippus</i> .
<i>Argynnis hyperbius</i> ♀.	„ ———
<i>Pareronia ceylonica</i> ♀.	„ <i>aglea</i> .
<i>Prioneris sita</i> .	<i>Delias eucharis</i> ,
<i>Papilio clytia</i> race	
<i>lankeswara</i> ♂ ♀.	<i>Euplœa</i> (several species).
<i>Papilio clytia</i> form <i>dissimilis</i> .	<i>Danaïs aglea</i> (and allies).
<i>Papilio polytes</i> ♀.	<i>Papilio aristolochiæ</i> .
„ „ form <i>romulus</i> ♀.	<i>Papilio hector</i> .

And the Müllerian combination of the three *Euplœas*, *core*, *coreta*, and *klugii*.

Euplœa coreta and *E. core*, as a reference to Mr. Moulton's plate

in Trans. Ent. Soc. Lond. for 1908 will show, are extremely alike, yet under certain circumstances I can recognize them when on the wing without great difficulty. When herded together in shady jungle, as is their frequent custom, it is impossible to differentiate them; but when flying singly over an open space, the former appears a blacker and broader insect with a rather more flapping flight, by which I can usually distinguish it from *E. core*.

The resemblance between *Danaïs chrysippus* and *Hypolimnas misippus* ♀ is well known, and I have often found them mixed together in local collections, but on the wing under ordinary circumstances differential diagnosis is by no means impracticable: the female of the latter is almost invariably seen flying close to the ground selecting favourable situations for oviposition, and her method of flight, difficult to describe, differs from that of *D. chrysippus*, which oviposits on a shrub some four or five feet in height; when not thus engaged the two are undoubtedly difficult to distinguish at about ten yards distance, and it is curious how often the male of *H. misippus* mistakes *D. chrysippus* for a female of its own species. *Prioneris sita* can at once be distinguished from *Delias eucharis* by its rapid darting flight.

A case of resemblance, though not always stated to be one of mimicry, is that of *Argynnis hyperbius* female and *Danaïs plexippus* or *D. chrysippus*. This was remarked on by Butler so long ago as 1884 and has been repeatedly noticed since, particularly by Longstaff and Bainbrigge Fletcher. The resemblance is, however, entirely accidental, as their habitat in S. India and Ceylon clearly shows. Broadly speaking, if observed above 4000 feet, it will assuredly be *A. hyperbius*, if on the littoral and up to about 4000 feet, almost certainly *D. plexippus*; it is only on the confines of each other's territory that they in any way come in contact and where an error can be made. *Cethosia nietneri*, *Danaïs ceylonica*, and *Papilio clytia (dissimilis)* fly in the same localities, that is, in jungle where the light is very flickering. It is not only very difficult to distinguish them apart, but they are quite difficult to see, as their black and white marking tends to make them invisible. They also frequent the outskirts of jungle and even more open country, and here they are quite easy to distinguish, particularly *P. clytia (dissimilis)*, which is a larger and much yellower butterfly.

Mr. T. Bell considers *Cethosia* to be an unpalatable genus owing to the nauseous juices and leathery bodies of the species. *Euripus consimilis* very closely resembles a Danaid in both sexes, and would be considered an undoubted case of either Batesian or Müllerian mimicry: it is not a Ceylon butterfly, and I first made its acquaintance in the Nilgiris; by its lofty sailing flight, particularly in the female, I recognized it at a glance from a Danaid, which rarely or never ascends more than about ten feet from the ground.

It is more in their peculiar manner of flight rather than in any difference of colouring that model and mimic can as a rule

be distinguished; when at rest the difficulty is considerably greater, and I would draw particular attention how not infrequently butterflies of a similar pattern on the under surface of their wings chose the same resting places, and often the same bush or branch on which to settle for the night. The following two notes indicate this.

"Colombo, July 1909. I observed at sunset sixteen *Telchinia violæ* and some *Danaïs chrysippus* with their wings closed, at rest on a leafless bush; they exactly resembled withered leaves, and it was exceeding difficult at ten measured paces to distinguish the species, at about twenty paces it was very difficult to recognize them as butterflies at all, and at thirty paces they were practically invisible."

"Kullar, Nilgiris, 12.4.1910. In a grove of Areca palms *Euplœa coreta*, *E. core*, *Danaïs limniace* and *D. septentrionis* simply swarmed, they were in hundreds and hung in festoons from the palms. Though many of each kind were on each leaf, they usually kept together. It was deep shade, and the Euplœas seemed to match the decayed vegetation and the Danaïds the green leaves. There were also many *Danaïs plexippus* but no other butterflies."

With regard to the above quoted instances, Mr. R. C. Punnett, after a study of them for about six weeks, writes: "With the exception of *Argynnis hyperbius* and *Prioneris sita*, I have had frequent opportunities of observing all these cases, and in every one it has appeared to me that the resemblance is far less striking when the insects are seen alive than when they are exhibited pinned out in the orthodox way on cork. I have found that with very little experience the eye comes to distinguish the mimic from the model without hesitation. As a rule it is in the mode of flight that they differ from one another My impressions of all these so-called cases of mimicry which I have been able to see, is that the resemblances are certainly not sufficiently close to deceive the eye of a civilized man with a little experience of them. For that reason I am inclined to doubt whether they would systematically deceive an enemy brought up among them, whose means of earning a livelihood depended largely upon the readiness with which he could distinguish between mimic and model. I do not wish to deny that in some cases, and upon occasion, the resemblance may be of service."

All local entomologists would endorse the above remarks, but there is this to be said, that Mr. Punnett was aware of these cases of mimicry before he arrived in Ceylon, and was on the look out for them; if he had been totally ignorant of them, it would have taken him some time before he recognized the phenomenon, but having once done so, he would no doubt have had no further difficulty.

The detection of certain cases of mimicry would appear to be greater in some countries than in Ceylon. Colonel Bingham, writing of the *Papilio clytia* group, says: "They have nearly all a wonderful resemblance to forms of *Euplœa* and *Danaïs*, and it

requires a quick eye and some experience to discriminate between *Euplecta* and *Papilio clytia* race *panope* and between *Danaüs limniace* and the *dissimilis* form of *P. clytia*, especially when on the wing." In reply to a query of mine on this point Mr. W. F. H. Rosenberg writes:—"London, August 29th, 1910. During my travels in Colombia and Ecuador I found that mimicking species *did* frequent the same places as their models. For instance, the Dismorphias (Pierines) which mimic certain groups of Ithomiine butterflies, such as *Ithomia zelica*, were seen flying in clearings in woods etc., in company with the Ithomias. It is curious to note, however, that there is a slight difference, difficult to describe, in the mode of flight of the two groups, so much so that a trained collector would rarely mistake one for the other. Again, the S. American Acraeines of the genus *Actinote*, which settle in groups on damp patches of sand, have their mimics in the shape of Nymphalines of the genus *Eresia*. But while the Actinotes will allow themselves to be picked up with the fingers, the Eresias always fly up on the approach of danger."

The Rev. St. Aubyn Rogers also, in his well known paper on East African butterflies, mentions how often at first he was deceived by model and mimic, but how after a short acquaintance he readily recognized them.

But confining myself to Ceylon, the ease with which every case of mimicry occurring there can usually be detected, causes me to be in sympathy with those who consider that this constitutes a great difficulty in the acceptance both of Batesian and Müllerian mimicry. Both reptiles and birds are well represented, and in order to afford a complete study of the fauna I propose taking them in order, first dealing with the reptiles. I can scarcely hope not to have overlooked some species, but I trust there is no serious error.

The Lizards of Ceylon.

Five families are represented; namely Geckonidæ, Varanidæ, Scincidæ, Lacertidæ, and Agamidæ. The first three of these are almost unquestionably of no account in our enquiry. The Geckonidæ are mostly nocturnal with but one diurnal species, *Gonatodes kandianus*, common in houses at Kandy and confined to that part of the island. The Geckos I have observed feeding at night were quite indiscriminate in their captures. Of the Varanidæ, two species are large carnivorous lizards, commonly called iguanas, frequently attaining a length of three or even four feet. One species when young ascends trees, and Mr. Rosenberg has seen a Mexican species eating butterflies.

The Scincidæ has four genera, *Acontias*, *Chalcidoseps*, *Lygosoma*, and *Mabuia*. The first has four species with limbs rudimentary or absent; in appearance they are very like our slow-worms but smaller. One species, *A. burtoni*, is usually found under stones, and the others, so far as I have been able to ascertain, inhabit similar situations. They appear to feed on

small worms. *Chalcidoseps* has but one species, *C. thwaitesii*, a small creature about two inches long with very short limbs. It is not represented in the Colombo Museum collection, and I am unacquainted with it. *Lygosoma* has three species, one found in the hills, the other two common in the low country. Their forelegs are very feebly developed, in fact almost rudimentary, and judging by their general appearance they probably have the same habits as the next genus, *Mabuia*, which contains two species, one of which is rather rare; the other, *M. carinata*, is the well known Brahminy Scink, which so far as my experience goes feeds almost entirely on ants, I have invariably failed to get it to feed on butterflies.

The family Lacertidæ has but one genus, *Cabreta*, containing a single species *leschenaultii*, very small and rare, found only at Mullative in the arid north-western district.

The Agamidæ has five genera, but three are represented by a single species in each. *Otocryptis bivittata*, a very small creature, confined apparently to the wet districts up to 2,000 feet: I have no personal acquaintance with it. *Cophotis zeylanica*, also small and found only in the hills: in captivity it feeds readily on flies, which it captures after the well known manner of the chameleon. *Zyriocephalus scutatus*, a magnificent creature found only in the outer hill-ranges, where the climate is hot and moist. My friend Mr. Alers Hankey, who has kept these species both in captivity and at large in his garden, informs me that they feed on "almost anything—moths, flies, beetles, grasshoppers, worms, and even boiled rice." We may conclude that their taste in butterflies, which they in all probability eat somewhat extensively, is impartial.

The genus *Ceratophora* has three species only, one of which I know, *C. stoddartii*, found only in the higher ranges. It feeds on worms and positively declined butterflies when in captivity.

The genus *Calotes* has seven species, three of which are somewhat rare; these I do not know nor one other, *C. mystaceus*. Two, *C. ophiomachus* and *C. versicolor*, are extremely abundant from the coast to about 3,000 feet, thence upwards *nigrilabris* takes their place and is likewise very common. All members of the genus have probably the same habits and are undoubtedly highly destructive to insect life. In fact I have little hesitation in saying that they are the greatest enemies that butterflies have to contend against, and when in Nuwara Eliya in 1909 I should have had no great difficulty in making a fair collection of butterflies mutilated by them. The injuries were of all kinds, but mostly a semi-circular piece, the size and shape of the lizard's jaw, had been taken out of the hind wing. These mutilated butterflies indicated no discrimination on the part of their enemy; perhaps *Argynnis hyperbius* was the most frequent victim. My experiments, though not so complete as might be wished, show that these lizards exercise no partiality; but the butterflies experimented with are those commonly found in the gardens at Colombo,

where *Calotes* is abundant, and almost all those which occur at Nuwara Eliya, the fauna of which is very poor.

Experiments with Lizards in Colombo.

The two species of reptiles experimented on belonged to the genus *Calotes* (*C. ophiomachus* and *C. versicolor*), or blood-sucking lizards as they are commonly called. In appearance and habits they are far more like Chameleons than ordinary Sand-Lizards, and like them have the faculty of changing colour and assuming on occasions brilliant scarlet, yellow and green, particularly about the head; but on the other hand they are very quick in their movements and can run with considerable speed. They are usually to be found sitting on walls and palings, clinging to the stems of the longer grasses, and frequently lying in wait for their prey behind the umbels of flowering shrubs, where their gaudy colours help to deceive visiting insects. In such positions they will wait motionless for hours on the chance of prey coming within reach. But as I was unable to devote a whole day for such prolonged investigations, I adopted the following method as being the nearest approach to natural circumstances. I attached a defunct or moribund butterfly by a long line of fine silk to a fishing-rod, and thus succeeded with the help of the wind in bringing the fly within reach of the reptile. The following were the results from the end of November to the end of December 1908, with the notes I made at the time.

November 24. A male *Papilio polytes* was waved over a green *Calotes ophiomachus* which was clinging to some grass. The lizard became slightly excited and made a grab at the insect, biting out a piece of the fore wing and immediately eating it; a second time it bit a piece out of the hind wing including the tail; the insect if alive would certainly have escaped on both occasions. Finally it seized it by the head and ate the remainder.

November 30. A female *Papilio polytes* of the black and white variety offered in the same way to another *Calotes*. This lizard, which was evidently hungry, became excited when he saw the butterfly, and made a grab at it and bit out a piece of the fore wing which it promptly began to eat; the butterfly would have escaped. While this "fishing" was going on, a male butterfly attracted by the female flew quite close to the lizard, which made a dart at it and tore away a piece of its wing, and the butterfly flew off. A lizard grabs at any part of the butterfly that comes within reach, and as the grass sways when it moves it is quite a chance what part is seized; the habits of *Calotes* therefore negative any theory of so-called directing marks so far as they are concerned.

November 25. The wings of the black and white variety of *P. polytes* are quite common in the garden, and I am quite sure the *Calotes* devour great numbers of them. I saw *C. versicolor* with a live one in its mouth; on this occasion it was holding the

insect by the fore wing—when it saw me it ran to a tree, and I fancy dropped the insect which, as I could not find it, probably flew away.

December 4. Saw *C. versicolor* seize *Delias eucharis* on the wing. On this occasion the lizard was in the foliage at the top of a bush, and sprang out and captured the butterfly as it flew past.

December 6. *Euplexa core* was eagerly seized, held in the mouth for a long time and then eaten.

December 7. *Telchinia violæ* was eagerly seized by the body and devoured.

December 9. Two *Danaïs chrysippus* taken one after the other by a green *Calotes ophiomachus*. It watched the butterfly, seized it by the body, and ate the whole of it after holding it in its mouth for some minutes.

December 18. *Papilio (Menelaides) hector* seized as soon as seen, held in the mouth for some time and eaten slowly. The lizard seemed very puzzled at the dryness of its meal as the butterfly had been dead five days, but finally ate it all.

December 20. *C. ophiomachus* ate a male *Papilio polytes*.

December 30. Saw *Terias hecabe* captured by *Calotes versicolor*.

During these two months butterflies and other insects were very numerous owing to the rain at the break of the N.E. monsoon. The tall Mauritius grass in the garden was a place of refuge for the butterflies during the heavy rain, and numbers of them could be seen any morning sunning themselves and sitting with expanded wings halfway up the grass stems. *P. polytes* and *P. demoleus* were particularly numerous and several had pieces taken out of their wings, no doubt by lizards. It was an interesting fact that so long as the butterflies remained perfectly still, they were entirely unnoticed by the lizards, though they might be in close proximity to them. Both these butterflies rest throughout the night with wings widely expanded.

Experiments with Lizards in Nuwara Eliya, 6,200 ft.

Three species were experimented on, *Calotes nigrilabris*, *Cophotis zeylanica*, and *Ceratophora stoddartii*. All three are peculiar to Ceylon and confined to the hill-districts. *C. nigrilabris* is about a foot in length including the tail, and is brilliant emerald green with a black bar across the lips. It has the same habits as *C. versicolor* and *C. ophiomachus* but is much tamer; in fact it is not at all difficult to capture with the hand as it rests on a bush.

Calotes nigrilabris.

3.3.09. Ate a *Terias hecabe* greedily, and another shortly after.

3.3.09. The same lizard ate another *T. hecabe*, and another made frantic grabs at *E. core*, dangled as usual at the end of a

string; when eventually I allowed it to take it, it ate it readily. The same lizard ate *T. hecabe*.

7.3.09. Another lizard ran out from its bush and caught *Terias libythea*. A *Papilio aristolochiae*, a very scarce species in N'Elia, caused great excitement in a male and female on the same bush; they rushed out to capture it, then drew back apparently frightened at its size and at length would have nothing to do with it. Offered to another it was seized by the fore wing and a part only eaten, the reason being that it was frightened of me. Offered again to the first pair they took no notice of it, but one made a jump of quite six inches and snapped up a fly which had settled on a leaf. This shows that they were hungry at the time.

15.3.09. A fresh *Appias galene* ♀ readily taken, but not so eagerly as by another which had recently changed its skin and to which some of the slough was clinging. This was very hungry and made quite a respectable jump at *A. galene* ♂, which it caught round the body. Immediately afterwards it devoured *Catopsilia pomona*.

15.3.09. Offered *Papilio (Menelaides) hector* to a remarkably fine lizard, which caught it by the base of the hind wings; these it ate very slowly and dropped the rest, no doubt because it was too dry. The same thing happened with *Telchinia violae* and another lizard. These two butterflies do not occur in N'Elia.

16.3.09. A female moth, *Spilosoma melanopsis*, Fam. Arctiidae, with remarkably large brilliant crimson body and pink hind wings, the dull fore wings being removed, was at once taken by a lizard, which ran some distance after it. It proved a very considerable mouthful which took quite half an hour to get rid of.

During March, April, and May I noticed a very considerable number of butterflies, more particularly *Argynnis hyperbius*, with pieces taken out of their wings, usually the posterior portion of the secondaries. I have no doubt that almost all these injuries were caused by this species of *Calotes* which is very numerous at N'Elia. I might almost say there is a specimen on every bush.

19.3.09. A *Euploea core* ♂ proved very attractive; a half-grown lizard ran more than a yard out of the hedge and seized it by the head as it lay on the ground. With the same species a large male made a dart at *Danaïs fumata* attached as usual to a line of silk, caught it by the hind wing and devoured the whole of it. A smaller individual seated on a bush of salvia became highly excited by *Polyommatus batika* with its wings closed, and ran all over the plant after it, eventually catching it by the body; immediately afterwards it ate three *Terias hecabe*, one after the other.

24.4.09. A female lizard, and one I have frequently experimented on, ran from its hiding place and caught *Pyrameis cardui* by the head after considering for a moment its cryptic underside. Another scrambled over its bush in the usual way and seized *Lethe daretis* ♀ by the hind wing.

These lizards were very tenacious in their grasp: as a rule, after

capturing their prey, they hold it quietly in the mouth for some time, but if it struggles they immediately begin eating it. A renewal of a struggle leads to the same thing.

Cophotis zeylanica.

This lizard is found only in the hill tracts of Ceylon, and is most frequently found resting on tree-trunks in shady places. It has considerable power of adapting its colouring to its surroundings, but not to the same extent as the Chameleon. It is almost five inches long including the tail, which is usually two or three inches. It is extremely sluggish in its movements, depending entirely on its cryptic colouring to escape observation. It is quite harmless and can easily be taken in the fingers. It eats flies readily in captivity, but all my efforts, both with specimens at large and in captivity, to induce them to eat butterflies resulted in failure, even those with their wings entirely removed seemed only to frighten them.

The Horned Lizard. *Ceratophora stoddartii.*

This interesting reptile is also peculiar to the island, entirely confined to the hills, and I do not think it occurs below 5000 feet. It varies in colour from a vivid green with black bands (three only seen) to a uniform brown. It has the faculty of changing its colour according to the nature of its environment. Only once have I found it otherwise than on a tree-trunk in deep shade, where butterflies very rarely penetrate. All attempts to make it eat butterflies in the wild state failed, and the following is a note on a captured specimen:—"13.4.09. Put numerous flies in its cage, there appeared to be a diminution the following morning. Put *Terias hecabe* and *Pyrameis cardui* alive into its cage. It did not notice the latter as it rested with closed wings on the gravel, though within three inches of it; but when it moved its fore wings up and down—not in and out—it was on the alert and crept up to it, but before it had made up its cautious mind to attack, the butterfly flew off, hitting it on the snout in so doing, which utterly disconcerted it." I may say that about the only butterfly in the upper hill district which frequents shady places is *Lethe daretis*. *Mycalis* and *Ypthima* do not extend so high. The chance of a meal off a butterfly is therefore remote.

Dr. Willey informs me that its natural food is small worms.

It would seem then that those who assume that reptiles take no part in the production of Batesian or Müllerian mimicry are correct, though further experiments are required.

The Insectivorous Birds of Ceylon.

A few introductory remarks are needed before dealing with the insectivorous birds. Speaking generally the Mimicrists, if I may use the term, maintain that birds do eat butterflies largely; the Anti-Mimicrists that they do not. The evidence of the latter is

necessarily negative, and we must therefore try to find some reasonable standard by which we can judge whether a particular bird is a butterfly eater or not. We shall not be far wrong if we employ the criteria accepted by Mr. Guy Marshall in his paper "Birds as a factor in the production of Mimetic Resemblances among Butterflies" (Trans. Ent. Soc. Lond. 1909), only in this case in a contrary sense. Speaking of the want of real evidence on the part of the Anti-Mimicrists, he says:—"When a naturalist who has spent some time in the tropics expresses a decided opinion to the effect that birds do not normally eat butterflies, because he has never observed them doing so, it is incumbent on us, before accepting his evidence as having any real scientific value, to satisfy ourselves that he has made a systematic and thorough investigation of the subject, and that his views are not based merely on casual and inadequate observations. For in a matter of this kind there is grave danger that absence of evidence may be due simply to lack of observation. If a collector maintains that birds do not eat butterflies, we are justified in asking him for a *full list* (italics mine) of the other insects which he *has* seen captured by birds. And I venture to think that a closer inquiry of this kind would reveal the fact that most of the negative evidence which has been brought up against the Selectionist interpretation of mimicry is really of little worth."

Passing over the obvious reply that as it was the Selectionists who first asserted that birds ate butterflies, it is their duty to prove it if they wish their theory accepted, it would appear that Mr. Marshall does not consider it necessary for an observer to be very accurate as to the species captured before attributing butterfly-catching propensities to certain birds.

In the case of the Redstart we read that "They take flies, gnats, small butterflies, and all sorts of small two- and four-winged insects, partly on the wing and partly at rest"; and again, "It feeds on flies, gnats, small butterflies, and various other kinds of small coleopterous and other insects, caterpillars, etc." Now if such evidence is accepted, namely, that the Redstart eats butterflies, without the necessity of naming the individual species captured (though it might well be suggested that these small butterflies were really small moths), it would appear only just that when such an authority as Legge states that the food of the large Indian Cuckoo-Shrike consists of "caterpillars, grasshoppers and various other kinds of coleopterous insects" without mention of butterflies, that such should be regarded as sufficient evidence that butterflies are not destroyed by it in sufficient numbers to cause any form of mimicry. But, on the other hand, when we read of a bird feeding "on beetles and the many larger members of the insect kingdom which affect Ceylon forests," it is quite possible that such a one would produce a struggle for existence among butterflies. It is only by adopting some such standard as this, faulty though it may be, that we are likely to come to any conclusion. As to the actual observation of insects captured by birds, no one who has not

experienced it can form an idea of its difficulty. Let any one who would appreciate it, watch a blackbird or thrush in his own garden, and even with the best field-glasses he will be unable in the great majority of cases to name the species of insect caught, or more frequently than not the order to which it belongs. In the tropics the difficulties are increased a hundredfold : fortunately in the case of butterflies the task is lighter, and it is often easy to name the species owing to the habit some birds have of holding the insect in the bill for a few moments before swallowing it, and the lengthy time it takes others either to tear off the wings after the manner of Shrikes, or beat them off against the ground as is the custom of the Robin family. Bee-eaters and Paradise Flycatchers nip off the wings close to the body as neatly as if done by a pair of scissors.

A certain number of birds are migrants, such as the Cuckoo and Swallow, which pass a portion of the year in Ceylon and the remainder in northern latitudes ; such birds, as pointed out by Mr. Marshall, would have to learn the distastefulness or otherwise of the butterflies that inhabit such dissimilar countries, and their influence on the butterfly population of both areas would have to be taken into consideration. These are, however, few in number compared with the partial migrants, which move from one part of the Oriental region to another ; and the butterflies there being of the same character, the lessons they have learnt in one part of their distribution are valuable to them in another. A great many of the resident insectivorous birds move in an irregular manner from one part of the island to another according as their food supply varies, and as this consists of insects alone it is largely dependent on the rainfall. Such a movement cannot be strictly termed a migration and may be a few miles only ; for instance, the rainfall in Colombo is about eighty inches, twenty miles off it is nearly two hundred ; when there is a comparative paucity of insect life at Colombo the birds, or rather some of them, find plentiful sustenance by moving a few miles inland. Some birds again, such as the Robins, remain in and about the houses and gardens year after year, and others, such as the Green Bee-eater, are never found in the wet portion of the island.

It is this slight to and fro movement which makes me sceptical of any insectivorous bird in Ceylon, and probably in any tropical island, being ever really hard up for food.

Mr. Marshall quotes Dr. Franz Doflein as writing : " From the observations which I made in the jungles of Ceylon, it is quite incomprehensible to me how naturalists who have spent years and tens of years in the tropics can deny the fact " [that butterflies are frequently attacked by birds]. I had very little doubt when I read this passage that Dr. Doflein was speaking of the north of the island, and his recorded observations confirm this ; I should, however, be very surprised if he could say the same of the whole island, more particularly the hill districts. One point to which I wish more particularly to draw attention, is his suggested immunity from attack of the magnificent *Ornithoptera darsius*,

attention being drawn by him to "its slow, lazy and almost unwieldy flight," the characteristics of an unpalatable butterfly. It does not occur or very rarely in the north of the island, where a bird, the Paradise Flycatcher, is very abundant, but at Kandy, to which place every visitor goes, and where possibly Dr. Doflein made his observation, the butterfly is very common and the bird rare, though I have seen it. But it so happens that at the foot of the Nilgiris, both bird and butterfly inhabit the same district and the former is an inveterate enemy of the latter, it eats numbers of them by nipping off the wings and swallowing the body. The slow, lazy flight may possibly advertise its unpalatability to some birds, but it makes it the easier victim to the Paradise Flycatcher, which in my opinion is the greatest enemy butterflies have in this part of the world.

I have always experienced considerable difficulty in understanding how a distasteful butterfly has acquired a slow sailing flight*. It is easy to see how swift flight could be brought about by natural selection, but the converse is not so clear. Presumably *Euplœas*, *Danaines*, etc., have always been distasteful on account of the poisonous or nauseous nature of the food-plants, and those of slower flight, as in the case of the palatable kinds, would naturally be first captured, and we can understand how a race of quickly-flying evil-tasting butterflies would be evolved by natural selection. But if quick flight is of assistance in enabling a tasty butterfly to escape capture, I find it difficult to believe that a nasty one, with equal powers of flight, would not be equally benefited. And if this be so, slow flight for the purpose of advertising unsaleable goods seems unnecessary and the method by which it has been evolved very obscure.

When we come to study fast-flying butterflies in their native haunts, we find in every case a different rate of flight according to the hour and weather. If it is a cloudy morning they fly much slower than they do in hot bright sunshine; the majority fly their fastest after 10 A.M. till 3 P.M., often resting between 12 and 2. But in the early morning and late afternoon, these same butterflies can often be captured with the greatest ease, as at this time they are usually feeding. This is the case with the rapidly flying *Teracolus* (*fausta*, *danae*, &c.) and many *Papilios*, and this may account for the different opinion Dr. Doflein and I hold regarding *P. hector* and *P. polytes*. He considers them to be of swift flight, and so no doubt they are in the middle of the day, and particularly when flying over bare ground from one patch of cultivation to another; but on a dull day or early in the morning or evening they are particularly easy to catch. If Dr. Doflein is correct we have here an instance of a Müllerian combination of

* Mr. Marshall speaks of "the acquisition of unpalatability," by which I presume he means that a slightly nauseous butterfly has become more so by a process of evolution, and this has been accompanied by an increasingly slower flight. There is no proof, so far as I know, that a *Euplœa* for instance has undergone any such process, and the assumption appears to be entirely theoretical.

unpalatable butterflies adopting or having a naturally quick manner of flight which enables them more or less successfully to avoid the tasting experiments of young birds. I mention this in order to show the difficulties that beset us even in the field, and how two observers may form a diametrically opposite opinion on apparently such a simple matter as the flight of a butterfly. Dr. Longstaff is no doubt correct in saying that *P. polytes* has a quicker flight than *P. hector*.

This varying velocity of flight makes me somewhat sceptical that swiftness has been evolved in order to escape capture, as an enemy by selecting the opportune moment can effect the seizure of a fast-flying butterfly as easily as one of slow and laborious flight. Those foes of butterflies, the Bee-eaters, feed during the hot hours of the day, and Drongos in the morning, late afternoon, and often after sunset.

Many butterflies are conspicuous under one set of conditions and the reverse in another, even at the same time of the day. *Telchinia violæ* is said to belong to the most distasteful group of butterflies. Its flight is slow and deliberate, and it is very conspicuous when flying over a grass field; its bright brick-red colour forms a strong contrast against the green, and it thus has the characteristics of an inedible insect. In the blazing dazzling sunshine on the dried-up plains of India its colour so matches the soil that it is decidedly difficult to see, particularly the female which is almost invisible. Its under surface matches admirably the dried-up leaves of the bush on which it frequently takes up its position for the night, and under these circumstances it has all the characteristics of an edible insect. On a day in March this butterfly was flying over the green gardens of Colombo, and three days afterwards I met it at Trichinopoly, with a shade temperature of 104°, dazzling sunshine, and scarcely a blade of grass to be seen. It will probably be held by Selectionists that in certain cases such as in extremely dry weather, even an inedible butterfly requires concealment and that conspicuousness is beneficial to it as advertising the worthlessness of its goods in the wet season, when insects are abundant. I have given my reasons for believing that in tropical islands there is no real scarcity of insect life that cannot be made good by birds. It may also be argued that its invisibility one moment and conspicuousness the next may be of advantage to it, but if this be so, it is difficult to understand why such an extremely distasteful insect as an *Acræa* is held to be, should be obliged to pass through such a complicated process of evolution.

In compiling the following list of birds, I have followed Oates and Blanford, as their nomenclature is more modern than that of Legge; where not otherwise indicated, the notes in inverted commas are quotations from Legge.

Captain Legge spent eight years in Ceylon, and those who were there with him, now few in number, have a clear recollection of his knowledge, zeal, and painstaking industry.

Fam. CRATEROPIDÆ.

Subfam. CRATEROPINÆ. (The Babblers.)

"All feed on the ground like thrushes. They . . . probably derive no portion of their food directly from trees, the fruit they occasionally eat being picked off the ground as they forage for insects." (*Oates*.)

1. The Southern Indian Babbler. *Crateropus striatus*.

"Its food is entirely insectivorous, and is mostly taken by scratching among leaves and débris on the ground."

2. The Ceylonese Babbler. *C. rufescens*. Indigenous.

"I found the stomachs of several examples killed in the month of August to contain portions of a large black beetle which was affecting the jungle in large numbers at the time."

3. The Ashy-headed Babbler. *C. cinereifrons*. Indigenous.

"Delights in exploring the mossy recesses of fallen trunks, in which humid spots it finds an abundance of caterpillars, bugs, hemiptera, and coleopterous insects."

4. The Ceylonese Scimitar Babbler. *Pomatorhinus melanurus*. Indigenous.

"Goes about in small companies searching for its insect food on low branches or clinging woodpecker fashion to the trunks or large branches, about which it jumps and twists itself with considerable agility."

Subfam. TIMELINÆ.

5. The Small White-throated Babbler. *Dumetia albigularis*.

"Its food consists of the larvæ of various insects and minute coleoptera."

6. The Ceylon Yellow-eyed Babbler. *Pycitorhis nasalis*. Indigenous.

"I have always found its food to consist of small coleoptera and various minute insects."

7. The Brown-capped Babbler. *Pellorneum fuscicapillum*. Indigenous.

"It feeds on the ground in dense thickets, picking up beetles and insects from amongst decaying herbage; it rarely shows itself in the open."

8. The Black-fronted Babbler. *Rhopocichla nigrifrons*. Indigenous.

"This modest but active bird frequents underwood, thickets and tangled jungle subsisting entirely on various insects and their larvæ."

There is no indication among the Ceylon Babblers of any

butterfly-eating propensity, but Mr. Frank Finn experimented with an Indian species (*Crateropus canorus*), and came to the conclusion that they distinguished in time between a tasty and distasteful butterfly. The note I made at the time I studied his experiments is as follows:—It is evident that they had no notion at first as to what was palatable and what was unpalatable, but as the experiments proceeded they learnt gradually to discriminate I conclude that as these birds with one exception were adult when captured, they could not have undertaken tasting experiments when young, otherwise they would have recognized a distasteful species.

Subfam. BRACHYPTERYGINÆ.

9. The Indian Blue-Chat. *Larvivora brunnea*. A migrant.

"Appears to feed entirely on the ground." (*Oates*.)

10. The Ceylon Arrenga. *Arrenga blighi*. Indigenous.

"The food consists of various insects and in the stomach of my specimen I detected the bones of a frog." Mr. Oswin Wickwar tells me that he found a species of snake, *Aspidura* sp., quite four inches long in the stomach of the bird shot by him.

11. The Ceylon Short-wing. *Elaphrornis palliseri*. Indigenous.

"Found in thick brushwood feeding on the ground." (*Oates*.)

"It feeds on ants and other minute insects and to some extent on small seeds."

12. The Indian White-eye. *Zosterops palpebrosa*.

13. The Ceylon White-eye. *Zosterops ceylonensis*.

These species have the same habits as those in Bourbon and Mauritius.

Subfam. LIOTRICHINÆ.

14. The Fairy Blue-bird. *Irena puella*.

"It feeds principally on fruit." (*Oates*.)

15. Jerdon's Chloropsis. *Chloropsis jerdoni*.

"Seeds may often be found in its stomach, though they are not so generally partaken of as insects."

16. The Malabar Chloropsis. *C. malabarica*.

"Lives on fruit and insects, chiefly the latter."

17. The Common Iora. *Egithina tiphia*.

"I have occasionally seen it dart out and seize a passing moth or butterfly on the wing and alighting again swallow it whole, a habit which is testified to by the large Mantidæ and other winged insects which are often found in its small stomach." "Frequents orchards feeding on insects which it finds among the leaves." (*Oates*.)

Subfam. BRACHYPODINÆ.

18. The Southern Indian Bulbul. *Hypsipetes ganeesa*.

"Its diet consists of fruits, seeds and berries it, however, also feeds on insects, and I have observed it occasionally dart at them from its perch, although its usual manner of capturing them is to seize them from the branches of trees, to which it will sometimes cling after the manner of a Tree-creeper."

19. The Madras Red-vented Bulbul. *Molpastes hæmorrhous*.

"Feeds mostly on fruit." (*Oates*.)

20. The Yellow-browed Bulbul. *Iole icterica*. Indigenous.

"I have found it to be more insectivorous than frugivorous."

"It wanders about in small flocks, feeding almost entirely on fruits and seeds." (*Bourdillon*.) "In all the specimens I have examined I have found fruit only in its stomach, but from the strong bristles at the base of the bill I suppose it may, at certain seasons, partake of insects." (*Jerdon*.)

21. The Black-capped Bulbul. *Pycnonotus melanicterus*. Indigenous.

"It is chiefly insectivorous, small seeds are sometimes devoured by it, and I have found snails of some little size in its stomach."

22. The Yellow-eared Bulbul. *Kelaartia penicillata*. Indigenous.

23. The White-browed Bulbul. *Pycnonotus luteolus*.

"It is both insectivorous and frugivorous, chiefly the latter, and there is nothing to which it is more partial than the seeds or berries of the latana plant."

Bulbuls are very frequently kept as cage birds, and have perhaps been more often experimented with than any other tropical bird. Those I kept years ago ate any butterfly given them, and I think it is now generally acknowledged that those species which are known to be insectivorous also attack butterflies, but they show no discrimination in eating them.

Fam. DICRURIDÆ. Drongos or King Crows.

All the Drongos are known to eat butterflies.

24. The Black Drongo. *Dicrurus ater*.

"The principal food consists of coleoptera, grasshoppers, winged termites, of which it is very fond, and ticks, which latter it takes from cattle. It has been known to devour small birds."

25. The Indian Ashy Drongo. *D. longicaudatus*. Migratory.

26. The White-vented Drongo. *D. leucopygialis*. Indigenous.

"It is entirely insectivorous, its diet consisting chiefly of beetles, bugs, termites and such like."

27. The Ceylon Black Drongo. *Dissemuroides lophorhinus*. Indigenous.

"Damp forests and even their most gloomy recesses are frequented by this fine bird It feeds on beetles and the many larger members of the insect kingdom which affect Ceylon forests."

28. The Larger Racket-tailed Drongo. *Dissemurus paradiseus*.

"Feeds chiefly at dusk when the bats come out."

The distribution of this family in the island is to be noted. The first species is confined to the Jaffna peninsula and north-west coast: I found it abundant on the opposite Indian coast in March. The second is migratory and does not breed in the island. The third is of general distribution. The fourth is confined to the heavy forests of the Western Province. The fifth to the North and Eastern Provinces.

Fam. SYLVIIDÆ. Warblers.

29. The Indian Great Reed-Warbler. *Acrocephalus stentoreus*.

"The diet consists of small flies and minute insects."

30. Blyth's Reed-Warbler. *A. dumetorum*. Migrant.

31. The Rufous Fantail. *Cisticola cursitans*.

"The diet of this species in Ceylon consists of many sorts of small insects and caterpillars." "The indigestible parts of the food, which consists of small beetles, caterpillars and little snails, are thrown up in pellets." (*Jerdon*.)

32. Franklin's Wren-Warbler. *Franklinia gracilis*.

"The food consists of small insects, which it picks up among the dead wood to which it is so partial."

33. The Broad-tailed Grass-Warbler. *Schoenicola platyura*.

"Feeds on the ground." (*Oates*.)

34. The Greenish Willow-Warbler. *Acanthopneuste viridanus*.
A migrant.

35. The Ashy Wren-Warbler. *Prinia socialis*.

"Its food consists of insects; but occasionally I have found small seeds in its stomach."

36. The Jungle Wren-Warbler. *Prinia sylvatica*.

"Its food consists of small coleoptera and other minute insects."

37. The Southern Wren-Warbler. *Prinia jerdoni*.

"It is purely insectivorous."

Fam. LANIIDÆ. Shrikes.

Subfam. LANIINÆ.

"These birds live entirely on insects, the Tree-Shrikes occasionally seizing a small bird or mammal. Some descend to the ground to seize their prey, a few catch insects entirely on the wing, and others, again, search branches and leaves for their food." (*Oates*.)

38. The Rufous-backed Shrike. *Lanius erythronotus*.

"A local bird feeds on grasshoppers, which it entraps on the ground, and also preys on Mantidæ and dragonflies."

It almost certainly eats butterflies. I have seen it occasionally in Colombo.

39. The Brown Shrike. *Lanius cristatus*. A migrant.

Certainly eats butterflies. See experiments on birds in Colombo (p. 737).

40. The Black-backed Pied Shrike. *Hemipus picatus*.

"They are rather flycatchers than shrikes in their habits
... continually darting out and seizing insects on the wing."
(*Oates*.)

41. The Common Wood-Shrike. *Tephrodornis pondicerianus*.

"Moths and small butterflies form a considerable portion of its food."

42. The Orange Minivet. *Pericrocotus flammeus*.

"Its diet consists of small butterflies and various winged insects. In the woods of the Horton Plains I saw it catching insects in the moss with which the trees are entirely covered in that damp region."

Mr. Ormiston tells me that he has known a small flock of these birds completely clear off some dozens of *Papilio polytes* larvæ, which he was hoping to rear on the fruit trees in his garden.

43. The Black-headed Cuckoo-Shrike. *Campophaga sykesi*.

"Its favourite food is caterpillars and other soft insects."

44. The Large Cuckoo-Shrike. *Graucalus macii*.

"Its food consists of caterpillars, grasshoppers and various kinds of coleopterous insects." Hodgson states its food to be "Mantidæ Scarabæi, berries, vetches and seeds."

45. The Little Minivet. *Pericrocotus peregrinus*.

"It feeds upon various larvæ (its favourite food) and small insects."

Subfam. ARTAMINÆ.

"They catch their food entirely on the wing, either by darting on it from a fixed perch or by flying about after the fashion of swallows." (*Oates*.)

46. The Ashy Wood-Swallow. *Artamus fuscus*.

This bird has been frequently quoted as having been seen by Colonel Yerbury to catch several *Euplœa core*.

Fam. STURNIDÆ. The Mynahs.

"They feed chiefly on the ground on insects and worms, but they are fond of fruit and berries, which they pick off trees." (*Oates*.)

47. The Black-headed Mynah. *Temenuchus pagodarum*.

Widely distributed and common.

48. The White-headed Mynah. *Sturnornis senex*.

A rare and local resident.

49. The Common Mynah. *Acridotheres tristis*.

See experiments on birds in Colombo (*infra*, p. 740).

Fam. MUSCICAPIDÆ. The Flycatchers.

"The Flycatchers feed on insects which they either catch on the wing, starting from a perch to which they usually return several times, or by running with the aid of their wings along the limbs of trees. They seldom or never descend to the ground." (*Oates*.)

50. The Indian Red-breasted Flycatcher. *Siphia hyperythra*.
Partial migrant.

See experiments on birds at Nuwara Eliya (*infra*, p. 735).

50(a). Tickell's Blue Flycatcher. *Cyornis tickelli*. Food?

51. The Blue-throated Flycatcher. *Cyornis rubeculoides*.
Partial migrant.

52. The Ceylonese Dusky-blue Flycatcher. *Stoparola sordida*.
Indigenous.

See experiments on birds at Nuwara Eliya (p. 735).

53. The Brown Flycatcher. *Alseonax latirostris*. Migrant.
The habits of this bird are well known.

54. Layard's Flycatcher. *Alseonax muttui*. Partial migrant.

"In the stomach of one example I found much larger insects (moderately sized coleoptera) than I expected to find captured by so small a bird."

55. The Grey-headed Flycatcher. *Culicicapa ceylonensis*.

Jerdon says it feeds on small insects.

56. The Indian Paradise Flycatcher. *Terpsiphone paradisi*.
Partial migrant.

See correspondence (*infra*, pp. 728 & 730).

57. The Indian Black-naped Flycatcher. *Hypothymis azurea*.

Mr. Oswin Wickwar has given me the following interesting note:—

“I watched two flycatchers of this species diving into a small pond evidently in search of some aquatic insect. They both dived in the most determined manner about five or six times, and, although I looked carefully, I could not find any insects on the surface of the water. They did not swoop down and just touch the surface of the water in the manner of swallows, but deliberately dived in with a splash like a kingfisher; there was a momentary pause, and then they fluttered back to the same perch or one near about where they started from.”

58. The White-browed Fantail Flycatcher. *Rhipidura albifrontata*.

“The chief food consists of mosquitoes and other small dipterous insects, as also the small Cicadella.” (*Jerdon*.)

FAM. TURDIDÆ.

Subfam. SAXICOLINÆ. The Chats.

“The Chats feed entirely on insects they capture generally on the ground from a fixed perch, such as the summit of a stone, a stalk of grass, or a branch of a bush, and then return at once to their post of observation.” (*Oates*.)

59. The Southern Pied Bush-Chat. *Pratincola atrata*.

“The food consists of insects and larvæ of various kinds, which they take chiefly on the ground.” This bird is also known as the Nuwara Eliya Robin; it has very much the habits of the Stone-Chat.

60. The Black-backed Indian Robin. *Thamnobia fulicata*.

Has been known to capture *Neptis varmona*; it usually feeds just at sunset and as long as there is light.

61. The Magpie Robin. *Copsychus saularis*.

See experiments on birds in Colombo (p. 737).

62. The Shama. *Cittocincla macrura*.

“Those shot in Ceylon seemed to be entirely insectivorous, the food consisting of small beetles, ants, flies, etc.”

Subfam. TURDINÆ.

63. The Ceylon Blackbird. *Merula kinnisi*. Indigenous.
Has almost precisely the habits of the English Blackbird.

64. The Ceylon Thrush. *Oreocincla imbricata*. Indigenous.
“Decidedly an uncommon bird . . . it appears to feed on insects which it procures beneath fallen leaves.” “Thwaites says it scratches much in rubbish thrown out at the border of his plantation.”

65. “The Spotted-wing Thrush.” *O. spiloptera*.

“Generally to be found in thick damp jungle picking up pupæ, coleoptera and other insects.”

Three species of Swallow occur; one, the Common Swallow (*H. rustica*), is migratory, the other two have similar habits.

Fam. MOTACILLIDÆ. Wagtails.

There are four species of Wagtails, three of which are migrants; the fourth, the Large Pied Wagtail, has the same habits as the rest of the family.

66. The Indian Pipit. *Anthus rufulus*.

“Feeds on worms and various terrestrial insects and likewise partakes of small grass seeds.” I have noticed it feeding on green Aphides, and once saw it capture a Lycænid, a species of *Zizera*.

Fam. CORACIADÆ. The Rollers.

67. The Indian Roller. *Coracias indica*.

“I have on several occasions seen one pursue an insect in the air for some distance and when the winged termites issue from their nests after rain, the Roller, like almost every other bird, catches them on the wing.” (*Jerdon*.)

“Its food is chiefly large insects, grasshoppers, crickets, Mantids, and even beetles, occasionally a small mouse or shrew.” (*Jerdon*.)

Family MEROPIDÆ.

68. The Common Indian Bee-eater. *Merops viridis*.

69. The Blue-tailed Bee-eater. *M. philippinus*.

“A winter visitant . . . it feeds on wasps, bees, dragonflies, beetles, and even butterflies.” (*Oates*.)

70. The Chestnut-headed Bee-eater. *M. swinhoei*.

“Locally distributed throughout Ceylon.” Not found in the hill country.

These three species are well-known as butterfly-eaters; see correspondence (p. 727).

Fam. ALCEDINIDÆ. Kingfishers.

71. The White-breasted Kingfisher. *Halcyon smyrnensis*.

"It occasionally, but rarely, catches fish by plunging after them, it lives chiefly on insects and small lizards and sometimes on mice and land crabs." (*Oates*.) "It subsists on lizards, grasshoppers, locusts, and even small snakes."

Fam. CYPSELIDÆ. Swifts.

72. The Alpine Swift. *Cypselus melba*.

73. The Common Indian Swift. *C. affinis*.

These birds have all the habits of the common European Swift.

74. The Palm Swift. *Tachornis batasiensis*.

"Feeds chiefly at dusk."

75. The Brown-necked Spine-tail. *Chaetura indica*.

"Mr. Carter says that those he shot had fed on beetles, green bugs, sand-wasps and grasshoppers." Mr. Spurway informs me that he has more than once seen it snap up a butterfly. Legge says it is fond of termites.

76. The Indian Crested Swift. *Macropteryx coronata*.

I know nothing about the feeding habits of this bird.

Fam. TROGONIDÆ. The Trogons.

77. The Malabar Trogon. *Harpactus fasciatus*.

Mr. Butler has seen a large moth brought to the nest he was observing.

"It feeds chiefly on beetles, moths or cicades; but it occasionally feeds on insects on the ground." (*Blanford*.)

Fam. CUCULIDÆ. The Cuckoos.

"They feed chiefly on caterpillars and soft insects." (*Blanford*.)

78. The Cuckoo. *C. canorus* Migrant.

79. The Small Cuckoo. *C. poliocephalus*. Migrant.

80. The Indian Cuckoo. *C. micropterus*.

"Feeds on caterpillars."

81. The Indian Plaintive Cuckoo. *Cacomantis passerinus*. A migrant.

"It feeds on caterpillars, coleoptera and other large insects, and may often be seen taking them on the ground."

82. The Banded Bay Cuckoo. *Penthoceryx sonneratis*.

"Feeds on coleoptera, Mantidæ, and caterpillars."

83. The Drongo Cuckoo. *Surniculus lugubris*.

"Locally dispersed . . . the diet is mixed, consisting chiefly of caterpillars and beetles but often combined with various seeds."

84. The Pied Crested Cuckoo. *Coccystes jacobinus*. Migrant.

85. The Red-winged Crested Cuckoo. *C. coromandus*. Migrant.

"The stomachs of those I have procured contained beetles, grasshoppers, Mantidæ, and other large insects."

FAM. FALCONIDÆ. The Falcons.

86. The Kestrel. *Tinnunculus alaudarius*.

Has the same habits as the English bird, which has recently been shown in some instances to have butterfly-eating propensities.

The above birds may be tabulated as follows; the arrangement is artificial, and no doubt there are errors, but it is convenient. Some may be inclined to transfer the Flycatchers from group 3 to group 1 on the evidence brought forward by Mr. Marshall in the case of the European Flycatcher. I have put them in the third group, as close observation for two months showed me that two species at any rate only eat butterflies under unusual circumstances.

Known to feed commonly on Butterflies.	Known to take Butter- flies occasionally.	May take Butterflies, especially the smaller species.
The Common Iora 1	Chats and Robins ... 4	Flycatchers 8
Drongos 5	Swallows 3	Babblers? 8
Shrikes 6	Wagtails..... 4	Warblers 9
The Orange Minivet 1	Trogon 1	Swifts 2
The Ashy Wood-Swallow 1	Cuckoos 8	The Little Minivet 1
The Paradise Flycatcher 1	Bulbuls 6	Chloropsis 2
The Roller 1	The Kestrel 1	
Bee-eaters 3	Mynahs 3	
The White-breasted Kingfisher 1	The Indian Pipit ... 1	
The Brown-necked Spine-tail ... 1		
TOTAL ... 21	TOTAL ... 31	TOTAL ... 30
4 of the above are either mi- grants (2) or partial migrants (2).	9 of the above are either migrants (4) or partial migrants (5).	6 of the above are either migrants (4) or partial migrants (2).

I would suggest this as a convenient place for a perusal of

Mr. Marshall's paper above quoted, more particularly that part devoted to the Indo-Malayan region.

For the sake of convenience I shall designate the birds in Group 1, "The Butterfly-Eaters," and the evidence in support of this term is given below under each species.

1. *The Common Iora and Butterflies.*

This bird belongs to the Bulbul family, another name for it being "The Common Bush Bulbul."

I have frequently watched this bird and can only confirm Legge's observations. Being so closely allied to the Bulbuls it is probable that, like its near relations, it is an indiscriminate feeder.

2. *King Crows (Drongos) and Butterflies.*

"On the 14th instant I was with Mr. C. B. Antram in a very small patch of wood surrounded by grass downs within a few miles of Ootacamund. Running through this wood was a foot-path, and this path was in one place a few feet long thickly strewn with the wings of butterflies; on either side of this, for some yards along the path, were scattered wings. Just above this place three Drongos (*Dicrurus*) were to be seen on the trees. The weather during my visit was misty, cold and rainy, and hardly any butterflies were on the wing; consequently I had not the opportunity of seeing the birds hawking them. Dragonflies were abundant and the Drongos made frequent excursions after them, all unsuccessful so far as I saw. On examination, the wings were found to belong to the following species:—*Danaïa limniace* (or *septentrionis*, or both), *Danaïa aglea*, *Danaïa chrysippus*, *Euplœa core*, *Euplœa coreta*, *Hypolimnas bolina* ♀, and *Catopsilia crocale*. At least 90 per cent. of the wings belonged to *D. limniace* or *septentrionis*. There were several wings of *Euplœa*, amongst which I found those of the males of both *core* and *coreta*. The remaining species were each represented by only one or two wings. These *Danainæ* are common in those parts, and in sunny weather would be passing in numbers through and over the wood, and the most common would almost certainly be *limniace*, *septentrionis*, *core* and *coreta*. *D. chrysippus* would be commoner probably on the outskirts of the wood. The only other butterflies about in any numbers when I was there, were *Argynnis castetsi* and *Colias nilgiriensis*, both eminently insects frequenting the open country, and they would seldom or never be found in anything heavier than scrub jungle. Some of the wings were obviously quite fresh, others had been beaten on the ground by rain. The three Drongos were almost the only birds about, and no other birds that we saw were likely to be capable of capturing these butterflies. It appears to me that the Drongos were certainly the cause of this extensive shower of wings; the only other possibilities are lizards or mantids, but no lizard, I should

imagine, has either the activity or voracity to make away with such a great number of butterflies, even assuming that they settled within its reach. A mantid is even less probable, and I much doubt if there is one large enough to tackle *Danainæ* or *Hypolimnas* in the Ootacamund region.

"One would not be surprised to find an occasional *Danais* or *Euplexa* sampled by a bird, but to see evidence of a systematic onslaught on butterflies which are so universally looked upon as leaders of the army of distasteful insects, and which are so widely mimicked by numerous 'unprotected' butterflies and moths, tends to make one sceptical of the accepted theories founded on the alleged value of this distastefulness. It is true that they may disagree with other birds, lizards, &c., but if one enemy alone can effect such wholesale destruction upon them, their immunity from death by violence is so seriously impaired that it seems to me that their numerous imitators amongst the 'Swallowtails,' &c., are simply asking for trouble.

"There was no lack of other food for the Drongos, and it can only be assumed that they found the *Danainæ* very much to their taste. One can hardly think of a morsel more apparently unpalatable than *Telchinia violæ*, yet I saw a Bulbul feed its young with one within a few feet of me. It would be interesting if entomologists would give any evidence in the matter which they can. I have seen the wings of *Hypolimnas misippus* sometimes scattered on the road near trees in considerable numbers, and on two occasions I have seen the wings of *Charaxes innia*; this I imagine was not caught on the wing; if so, I must congratulate the bird on its power of flight.

H. LESLIE ANDREWES."

Barwood Estate, Nilgiris, 20th October, 1910.

(Journal Bomb. Nat. Hist. Soc., vol. xx. p. 850.)

This interesting observation may be held to support Mr. Moulton's proposition (Trans. Ent. Soc. Lond. 1908) that the *Euplexas* of S. India are a Müllerian combination formed for mutual protection against the onslaught of insectivorous birds; but evidence is required that at one time they differed materially from their present day appearance.

I took the few notes following at Coonoor, 6000 feet, Nilgiris, S. India, in April 1910. I asked my collector, a half-caste who had spent all his life in the jungles, whether he had ever seen a bird catch a butterfly, and he immediately said he had, describing the Paradise Flycatcher very accurately. He said they eat the brown butterflies (*E. core* and *coreta*) and white ones. While he was speaking I happened to open an envelope containing *Danais septentrionis*, and he exclaimed, "I have seen them eat those too." He added the bird nips off the wings and swallows the body; also that they catch and eat the *Ornithoptera*. A few days afterwards I was at Kullar at the foot of the hills, about thirty miles from Ootacamund, where these birds and Drongos are common. I saw a Drongo in a lane, and close together on the ground

I found the wings of *Papilio hector*, *Euplexa core*, and *Danaïs septentrionis*, and a little distance further on another *D. septentrionis*. These were the commonest butterflies about at the time.

12.4.10. Kullar, 1200 feet. Saw a Bulbul dart out at a *Papilio hector* and miss it. Saw the following with notched wings: *P. demoleus*, one or two *Catopsilia*s, one or two *Teracolus fausta*, several *P. hector*, many *Junonia lemonias*, these last usually with oval pieces out of the secondaries, probably by *Calotes*.

10.4.10. Coonoor. Walking along a road I saw what I thought, at first, was a leaf falling from a tree about twenty feet up, but on going to look at it I found it was the fore wing of *H. misippus* ♀, *diocippus* form. It is curious that I have only seen one other female during the many times I have been along this road. I could not see the bird, but Bultuls are plentiful. Found also on the road the fore wing of *Papilio sarpedon*.

21.4.10. Kullar. Watched a Racquet-tailed Drongo for some time hawking after flies. I did not see it chase a butterfly though there were numbers flying about, chiefly Euplexas.

Mr. T. N. Hearsy, Indian Forest Service, writes:—"Coimbatore, 6.6.10. . . . I have frequently seen the common green Bee-eater (*Merops viridis*) and the King Crow (*Buchanga atra*) take butterflies on the wing, the butterflies being *Catopsilia pyranthe*, *C. florella*, *Terias hecabe*, and *Papilio demoleus*. The Bee-eater I have also seen taking *Danaïs chrysippus* and *Danaïs septentrionis*, and I remember to have been struck with their taste for those latter. . . I have also seen the Tree-Swift (*Dendrochelidon coronata*) take *Catopsilia pyranthe*."

In another letter he mentions having seen Drongos attacking dragonflies.

Mr. Ormiston, of Kalupahani, Hadumulle, Ceylon, 4500 feet, writes:—"Kalupahani, 4.2.09. Of course I will try and get you any notes I can on birds eating butterflies . . . I can give you very little assistance at present, as the only bird I have watched is the Fork-tailed Drongo, who eats the whites during a flight and attacks *Kallima*.

"The Magpie Robin and black-and-white Flycatcher catch a great lot of moths, but I have no notes of their taking butterflies. At Ohiya bungalow, after a moth night, we used to bottle all the moths we wanted, and then loose a tame Mynah who made short work of the rest, but I never tried him with butterflies. I will try the Robins in my garden, but the fact that they eat dead butterflies will not prove that they catch them. Personally I do not think birds make any appreciable difference to the number of butterflies except possibly by eating them in the larval stage. It is quite unusual to see a butterfly caught."

"Kalupahani, 3.1.10. I have kept my eyes open for butterfly-eating birds, but I am sure that the slaughter, if any, must take place in the larval stage. I have seen the Fork-tail Drongo feeding on the flight whites and *Kallimas*, but that is all.

"I have seen a dragonfly catch and kill *Zesius chrysomallus* and another fly killing *Papilios*, *Lycænidæ*, *Syntomiidæ*, with

apparently preference for the last named. Some black-and-white Flycatchers come close when I am beating for 'plumes' on the road here, and catch lots of common Pyralids I put up. The common Magpie Robin comes most mornings for the moths which I have slain at the lamp and discarded, and I have seen a Sparrow catch a gold-tail moth. But since you asked me a year ago to look out, I have not seen half a dozen cases of birds eating butterflies."

"Kalupahani, 26.6.10. I have kept my eyes open for birds eating butterflies but have no new notes. During the last flight the Fork-tailed Drongos were as usual feeding on the white butterflies, but that is the only instance I have seen. Certainly few, if any, birds eat the *Terias* family. I have watched them flying slowly with Swallows, Drongos, and Flycatchers close to them and leaving them alone. I fancy Bee-eaters take butterflies, but they are scarce here, and I have no data therefore to go on

"*Kallima philarchus* appears at Hadumulle in large numbers and the flight lasts for about a week. The biggest flights are very nearly always from about Christmas to the New Year, but a smaller flight appears in July. About once in four years they are especially common . . . They seem especially to favour Loquat trees, but come readily to a mixture of jaggery (native sugar), beer and rum. Instead of settling on the branches or trunk with their heads towards the top, they seem usually to do the opposite, and are therefore apparently very conspicuous; but the birds do not seem to notice them till they move (when they come to sugar they settle anyhow).

"The spot where I mainly catch them is about two acres of Grevilleas planted with a few Loquats. When the flight is on, the Grevilleas seem full of Forked-tailed Drongos, and as soon as a butterfly moves a Drongo darts for him, but usually only takes a big piece out of one wing. I have never seen the wings lying on the ground, so fancy if the Drongo gets him he eats wings and all. I have never, however, seen him catch one."

"10.10.09. Paducka. Watched Drongos (*Dicrurus leucopygialis*) hawking for flies; though *Mycalesis ceylonica* and small *Lycænids* were flying plentifully beneath the birds, they did not take them.

"19.12.09. Paducka. Watched several Drongos and a Paradise Flycatcher; the former frequently caught small flies in the air and occasionally came to the ground after bigger insects, but only once did one catch a lepidopterous insect and this seemed to me a moth. The Flycatcher took short flights on the ground picking up flies, but certainly not a butterfly. Came across five fully fledged Ashy-headed Babbler sitting all together on a branch; they flew off only when I approached quite close to them, with great chattering, very much like the ordinary Babbler; the old birds were hunting for food in the thick bamboo jungle. This is very late in the year for young birds."

I give these merely as samples of negative notes; there is no object in giving more.

Mr. E. Ernest Green writes :—

“Peradeniya, 16th July, 1910.

“With regard to the capture of butterflies by birds, I was told (in May last) by a lady who was staying with us, that she had been watching the Drongos in these Gardens busily catching butterflies. From her description, the victims seemed to be species of *Euplœa*. She said that the birds bit off the wings, and that the road was covered with the dismembered wings. I asked her to collect some of the wings for identification. But, in the meantime, they had either been swept or blown away, and she could only produce one or two wings of *Papilio jason* and *Jamides bochus*.”

The common brown *Euplœa* can hardly be mistaken for any other Ceylon butterfly.

3. *Shrikes and Butterflies.*

Dr. Willey, F.R.S., writes :—“The late Grant Allen stated positively that among the animals which he had seen in Butcher-bird’s larders were mice, shrews, lizards, robins, tomtits, and sparrows; but he added that in spite of its occasional carnivorous tastes, the Shrike is at heart an insect-eater.”

The few experiments I have been able to make leave little doubt in my mind that they make little or no selection in their butterfly diet. See below (p. 737).

4. *The Orange Minivet and Butterflies.*

I know nothing about this bird’s provender other than already given; Mr. Ormiston’s observation is, however, suggestive. The larva of *Papilio polytes* lives in its earlier stages exposed on the upper surface of the leaf of the orange or citron, looking exactly like a bird’s dropping; when irritated it shoots forward two fleshy “horns” emitting a pungent smell of orange, which is highly disagreeable. I presume this is derived from the food-plant, and if this be so the larva in all probability has a taste of unripe orange, and consequently it would seem that the bird’s palate is not highly educated and its taste in butterflies probably not selective.

5. *The Ashy Wood-Swallow and Butterflies.*

Mr. Walter A. Cave writes :—

“Colombo, 21st October, 1910.

“I am sorry I cannot help you much in regard to the question of butterflies being taken by birds. On one occasion I observed an Ashy Wood-Swallow (*Artamus fuscus*) tearing the wings off a butterfly, then swallowing the body. This was in Peradeniya Gardens a year or so ago. There were many of these birds, which are allied to the Shrikes, hawking over the Maha Weliganga river. I did not see this particular bird actually catch the butterfly, but I have every reason to believe it did, because I had a good pair

of prism binoculars focussed on the bird as it alighted in a tree. As I have said, the wings were first stripped, and as they fell I was able to make them out. I am not well acquainted with butterflies, but to make my notes complete I referred to the Museum and determined the butterfly as the commonest brown one we see about the roads here, and I put it down as *Eupléa core*.

"On another occasion I saw a Common Swallow (*Hirundo rustica*) take a small white butterfly, but I was too far away, and without my glasses, to determine the species. The Swallow was hawking near a piece of very dark jungle, near the Nuwara Eliya lake, and the white butterfly was very conspicuous against the background."

Colonel Yerbury's note of this bird being seemingly partial to *Eupléa* has already been alluded to.

6. *The Paradise Flycatchers and Butterflies.*

Mr. John Pole, Scarborough, Maskeliya, 6000 feet, writes:—"Maskeliya, 13.3.09. . . I seem to recall the attacks of the Odonata and even *Asylus* (Diptera) on butterflies, but I never remember an instance of a bird attacking one—I have watched the little Tailor-birds eating the larvæ of *Terias hecabe* and that with seeming distaste, and the Flycatchers at work on Diptera from the shelter of some leafy tree; I have had so large an insect as *Phyllades consolisma* taken from under my very nose by a Drongo, have had moths beaten from a fence in the daytime stolen by Swallows ere I could net them, but have never seen a bird in Ceylon carry off a butterfly. In England I have seen a Swallow carry off *Papilio machaon* whilst I was following it . . . I came out to this Island in 1871."

"Maskeliya, 17.3.09. Since writing on 13th we have had for two days (16th and 17th) flights of butterflies, the first I have seen this year. There has been in my garden for the last three months a bird, which generally goes by the name of the 'Cotton Thief' (the Paradise Flycatcher). This bird occupies a jak tree within twenty feet of my window, and for the last two days he has been obtaining all his meals from the flights of butterflies, and although I have never actually seen him catch one, I have seen him circling from the tree in pursuit and the wings of the insects he captures falling around the base of the tree within a radius of twenty feet. Should they be of any service to you, I can send you the wings of *Appias paulina* and varieties ♂ and ♀ as follows:—

Upper left wing, 4 ♂ 2 ♀.
 Upper right wing, 5 ♂ 5 ♀.
 Lower left wing, 5 ♀.
 Lower right wing, 2 ♂.

"Maskeliya, 14.4. . . I have only one more species of butterfly to give you as its food—*Papilio agamemnon*, and this is the only

butterfly to my best belief the bird has taken since my previous letter on the subject. The bird is rare here We have had no flights of the yellow and white *Catopsilia* this year—so no wings about—the *Appias* victims were mostly the white forms ♂ and ♀.”

7. *The Roller and Butterflies.*

I am unable to add much regarding this bird's dietary. It is found only in the dry northern districts and is uncommon. In the plains of India it is a familiar occupant of the telegraph-wire, and I have often seen it chasing and no doubt catching various insects from such a perch. I have no doubt it catches butterflies, and more than once am sure I have seen it do so, though I am unable to name the species captured. Judging by its very varied menu, I have little doubt that it pays little heed to the species it manages to catch, but of this I have no direct evidence.

8. *Bee-eaters and Butterflies.*

Mr. Fred. Lewis, a well-known ornithologist, writes:—“Colombo, 8.11.09 I have noticed Swinhoe's Bee-eater in particular hawking after the common so-called ‘Adam's Peak butterfly’ [*Catopsilia* and *Appias*], and it appears to prefer the white one to the larger yellow fly. It does not, so far as I am aware, take any of the large brown butterflies often to be found with the above named. I have watched the bird when quite a selection of flies could be made, but beyond taking the white and an occasional yellow, I have never seen it feed on others. I am not prepared to say, however, that the Bee-eater does not eat any other butterflies than the two mentioned.

“Our common black King-Crow appears to select the same flies, taking them on the wing in the same way as the Bee-eater. Swallows do not, so far as my observations go, ever touch any butterflies.

“It is remarkable, however, on such occasions as one finds in the dry zone, when vast masses of these ‘Peak’ whites and yellows congregate round some wet pool or damp ground, that King-Crows are not found taking the opportunity of a ‘square feed.’ I infer therefrom that the butterfly is only a ‘side dish’ and not a regular item of food. . . I cannot recall an instance of young birds being fed with butterflies. I suspect the difficulty of swallowing the wings is the reason, for I cannot say I have ever found small nestlings with anything so difficult of mastication in their nest. . . .”

In another letter Mr. Cave writes:—

“Belvedere, Colombo,
5th March, 1911.

“In reply to your letter I am sorry to say I have nothing further to report on the subject of the capturing of butterflies by

birds. I have the subject always in mind when I happen to get out, and my friend Mr. Symons, of the Government Training College, is also on the look-out, and if we should notice anything it will be reported to you.

"Being keen on birds there is very little that escapes my notice when I happen to be out, and I must say the subject on which you write is very exceptional so far as my observations go. At Christmas time I motored round the south coast to Galle, Hambantota and from thence to Haputale. The butterflies were there in myriads, nearly all the way—none of us had ever seen anything so remarkable in our lives. There were literally clouds of butterflies—in fact we remarked that we now knew where all the butterflies came from which used to appear here on migration in the N.E. monsoon. But neither Mr. Symons nor I saw a bird attempt to catch a butterfly, and we saw a large variety of birds including Bee-eaters, Swallows, and Swifts."

An argument of some force against the frequency of butterfly victims may be advanced by the different behaviour of birds in the presence of a flight of locusts and a migratory flight of butterflies. I have been fortunate enough to witness both, and the difference is very striking. In the former, every kite, crow, and insectivorous bird in the district follows the locusts, gorging to repletion; and it is a very remarkable sight the numbers, I might almost say flocks, of birds following the swarm. In a migratory flight of butterflies, on the contrary, with the exception of a few Bee-eaters and Drongos, birds are conspicuous by their absence.

Mr. Oswin Wickwar, F.E.S., sends me the following note:—"When shooting in the Northern Province in May last, I was crossing the dry bed of a river when a Bee-eater (*Merops viridis*) swooped down and caught a butterfly on the wing within a couple of yards of my face. The instant it snapped it up, the fore and hind wings of the butterfly floated down in front of me, and enabled me to prove its identity, *Papilio polytes* ♂. This was about 11 A.M. The following morning about 7 A.M. I had occasion to cross the same spot, and saw what was probably the same bird perched on a twig; I had hardly seen it, when it flew down and entered a hole in the bank, but came out again in a few seconds. This was evidently its nest, and I was anxious to look for remains of insects, nor was I disappointed. By introducing a twig, the hole seemed to be about two feet deep and to travel in a horizontal direction, so a start was made to cut away the bank, and before going a foot three insects were unearthed,—a humming-bird moth (*Macroglossa* sp.?) which was still alive, a 'skipper' (*Suastus gremius*) also alive, and a small green beetle with white spots on the elytra. All these were secured and taken away. The hole now took a turn and went a downward course for about two feet, which meant cutting away a huge piece of the bank to get at the nest, so I had to leave it."

The following extract is of much interest ; it is from the ' *Spolia Zeylanica*, ' 1910 :—

"Bee-eaters as Fish-eaters."

"There are a pair of Chestnut-headed Bee-eaters (*Merops swinhoei*), which nest pretty regularly in a steep bank on a road below my bungalow, and about 150 yards distant from my pond. Almost any bright afternoon, between 2 and 3 P.M., they may be seen fishing in the pond. They come down from a dead tree, which stands on a knoll some 50 yards away ; sometimes hovering for a moment over the water to locate their prey, but more commonly marking it in their swoop, and dashing headlong into the water like a kingfisher and very rarely missing their fish. I have seen the pair account for a dozen fish in as many minutes ; all quite small fry.

"When there is a flight of white butterflies on, these birds devote most of their attention to them throughout the day, but on warm bright days nearly always have a go at fishing in the afternoon.

"I have always hitherto associated Bee-eaters with the one diet of insects ; and I could not quite trust the accuracy of my eyesight until I brought a strong pair of field-glasses to bear on the actors at the short range of 15 to 20 yards. I think it probable that many so-called insectivorous birds change their diet when some chance has put them up to the taste of a new article which happens to suit them. . .

"Since the pair, which I convicted of fishing, hatched out their young, they have abandoned their fishing expeditions and may be seen sitting on the tree facing their burrows catching insects (chiefly white butterflies) to feed their nestlings.

E. GORDON REEVES."

Wiltshire, Matale, May 7, 1910.

9. *The White-breasted Kingfisher and Butterflies.*

I have often seen this bird eating grasshoppers, and on one occasion a butterfly which I was too far off to identify. Small frogs and lizards, some of the latter of quite a respectable size, I have also seen taken. Dr. Willey writes, "I remember being much surprised, many years ago, to find a Kingfisher's stomach full of insect remains." With such a mixed dietary its taste for butterflies is probably impartial.

Sparrows and Butterflies.

Mr. R. D. Hodgins writes :—" April 1911. These birds have built their nests about my bungalow here at Matale, so I have plenty of opportunity of watching them. I have on three

occasions noticed the birds hawk and catch butterflies in mid-air, and in two cases the butterflies caught were taken off the tree tops, but I could find no trace of them on the ground.

"The flies on one of these occasions were brown and on the other white, very like the common white cabbage butterfly of England, but I was some distance away and couldn't see them properly [probably *Euploea*, and *Catopsilia* or *Appias*].

"On the third time the butterfly was caught while passing the bungalow one sunny afternoon in February, but appeared to be released the moment later and dropped to the ground. Only its abdomen was taken and this was nipped off neatly at the waist. These wings I collected and herewith enclose [*Papilio sarpedon* : the butterfly was otherwise in remarkably good condition ; it is a very rapid flier.]

"I have often seen a sparrow dive and catch a feather floating in the air in a similar way to that in which a swallow does. Whether the feather is mistaken for a butterfly or *vice versa* I don't know.

"In the case of Ceylon native birds, I have been unable to detect any catches of butterflies, but have noticed that two of the species will take and devour moths This bird [the White-bellied Drongo] I have often seen catching flies from the branch of a tree or telegraph-wire with downward swoop on to the victim. I have often seen it catch small moths up to about one inch in length, which it seemed to devour, wings and all, after returning to its perch."

It would be as well to refer to the distribution of the "Butterfly-eaters." The Drongos have already been alluded to ; only one is of general distribution. The Common Iora is widely distributed. The Shrikes with two exceptions are found in the wooded country of the upper and lower hill districts, the other two I have seen only in the low country.

The Ashy Swallow-Shrike is a partial migrant in the island ; it appears in small flocks in Colombo during the north-east monsoon, at other times it is more an inhabitant of the north. The Roller is found only in the dry districts, so also are the Bee-eaters, particularly the Green Bee-eater, which is never found in the wet country or above 300 feet. Swinhoe's Bee-eater occasionally ascends higher, and the migrant Philippine Bee-eater appears for a short time on the wet western coast at the break of the north-east monsoon, but soon retires to the dry northern districts. The White-breasted Kingfisher and the Brown-necked Spine-tail are of general occurrence.

If this distribution is carefully studied, it will be noticed that there is a distinct paucity of butterfly-eating birds in the wet hill districts and that part of the coast subject to heavy rains ; though mimicry occurs quite as commonly, if not more so, as in the drier districts, where butterflies are less commonly met with.

Experiments on Wild Birds.

The following experiments were made on one bird in column 1, two birds in column 2, and two in column 3 (see p. 724), a very small percentage of the total number no doubt, but the best I could do under the circumstances, and they indicate the lines for future investigations.

Experiments on Flycatchers at Nuwara Eliya, 1909.

The Indian Red-breasted Robin Flycatcher, *Siphia hyperythra*.

This bird is migratory and is found only in the hill districts; it is about the size of the European Spotted Flycatcher.

30.3.09. Deprived live *Terias hecabe* one, *Terias libythea* one, *Hypolimnas bolina* ♂ one, *Danaïs fumata* one, *Neptis leucothoe* one, and *Appias galene* one, of about two-thirds or three-quarters of their wings, and put them on the ground near a tree from which one of these birds was accustomed to feed. It first made off with either the *Neptis* or *Danaïs*, I could not see which, then the *Appias*. It then flew away, and I picked up one of the *Terias* and *Hypolimnas*. This last had a good deal, perhaps half, the wings left and fluttered about vigorously.

1.4.09. *Lethe daretis* one, *Vanessa haronica* one, *Terias hecabe* one, and the same *H. bolina*, treated in the same manner as on the last occasion and put in the same place. The bird carried off the first two, but the *H. bolina* seemed too large for it, as it was for another Flycatcher which came along shortly after the first had flown off. I could not see what became of the *T. hecabe*. The same afternoon a similar experiment, but with no result.

9.4.09. This bird has evidently migrated as I have seen none since the last note. It nests in the Himalayas.

The Ceylonese Dusky-blue Flycatcher, *Stoparola sordida*.

This bird is peculiar to Ceylon but confined to the hill-tracts.

2.4.09. Placed *Terias hecabe* two dead, *Argynnis hyperbius* one, *Danaïs fumata* three, *Appias galene* one, these latter alive but largely deprived of their wings, near the cherry-tree much frequented by Flycatchers. The cock bird carried off one *D. fumata*, its mate another; the latter I was enabled to watch closely, and it had extreme difficulty in swallowing the fly on account of the wings. The former shortly afterwards returned and carried off the remaining *D. fumata*, but the latter seemingly had had enough of it. Shortly after a Red-breasted Flycatcher flew off with the *Appias*. What became of *A. hyperbius* I do not know, but the two dead *Terias* were untouched.

Numerous specimens of the above butterflies were flying about at the time, but I have never seen these Flycatchers molest them.

5.4.09. Placed *T. hecabe* one, *D. fumata* one, and *A. hyperbius*

♀ one, under the cherry-tree, having amputated both wings on one side close to the body. The cock bird flew down almost immediately and seized *D. fumata*, and as usual it had great difficulty with the wings; about ten minutes afterwards it took the *A. hyperbius*, but *T. hecabe* was left. I fancy the wings rather "put off" the bird.

29.4.09. The birds have a nest with young in a cherry-tree in the grounds. I put down *A. hyperbius* ♀, *T. hecabe*, *Neptis leucothoë*, and one or two others; they had all been dead some days and were very dry. After some time the bird noticed them, flew down and seized the *Argynnis*, which had its wings closed and showing the underside. It flew with it into a tree but very shortly dropped it, it was evidently too dry. I found it had been caught by the fore wings, one of which was gone with also a portion of one hind wing. The same afternoon put down live *Pyrameis cardui*, *N. leucothoë*, *T. hecabe*, *Appias nadina*, and *Euplœa core*, but with both wings on one side removed. The cock bird flew down among them and caused a great flutter; it first caught the *Terias*, then the *Neptis*, and lastly the *Euplœa*, which provided a great chase. It carried them altogether to the nest, but in feeding the young, the *Euplœa* escaped; the bird was after it in a flash, caught it again and carried it back to the nest. It was very interesting to watch its efforts to get such a large insect, the size of our Camberwell Beauty, into the young one's mouth. Three or four times it had to take it out and manipulate it in its own beak before another trial; eventually, it succeeded in forcing it down the youngster's gullet.

2.5.09. A half-winged live *A. hyperbius* placed near the nest. I am sure the bird noticed it, but beyond regarding it carefully it did not molest it.

I am convinced from long and repeated observation that the old birds never fed on butterflies themselves or fed their young with them. A critic, whose opinion I value highly, has objected that because I never saw one of these birds capture a butterfly, it is no proof that they did not do so and that very possibly the difficulty of catching them would only induce pursuit when the butterfly was off its guard and a capture possible. I do not know why the birds should be more coy of capturing a butterfly than a house-fly in my presence, and I can scarcely believe they took the opportunity of my absence to do so. Granted that difficulty of capture was the reason for non-pursuit, what chance, it may be asked, would a young bird with considerably feeble power of flight have of conducting a series of tasting experiments on these butterflies? It is not infrequent in the writings of advocates of mimicry to explain the rareness of attack by difficulty of capture; but by doing so they seemingly forget that if such is the case with old birds, it makes tasting experiments (with butterflies) very difficult for young ones.

*Experiments on Birds in Colombo.*The Brown Shrike. *Lanius cristatus*.

28.12.08. Pinned a large *Hypolimnas bolina* ♀ (a mimic of *Euplœa*) on a paling: in a few minutes the bird came along, and directly it saw the butterfly it pounced upon it and carried it off, and I could not see where it went, but I have no doubt it ate it.

29.12.08. Pinned a *Hypolimnas misippus* ♀ on the paling. The same Shrike saw it, seized it and held it in its claw, eating it piecemeal and tearing off two or three wings. The following day the same experiment was repeated with *Danaïs chrysippus* and *Telchinia violæ*, with the same result.

6.4.09. Nuwara Eliya. Noticed one of these birds, perched on a twig, fly down and capture some insect on the ground. I watched it for a long time, but though many butterflies flew past, it took no notice of them. They comprised principally *Argynnis hyperbius*, many *Appias* sp. ? *Euplœa core*, *Terias hecabe*, and *Lethe daretis*.

28.11.09. Colombo. Put down *Delias eucharis* ♀, several *Euplœa core*, *Danaïs limniace* 2, *Papilio hector*, and *Telchinia violæ* alive but mutilated. A Shrike came and looked at them keenly from a tree close by, but did not attack them. A small Cuckoo flew over them twice, but took no notice of them.

21.10.09. Put down *H. misippus* ♂ 5, *E. core* 4. The Shrike, perched in an oleander bush, evidently saw them, but for quite an hour took no further notice though it took several insects close to them. It eventually took one, perhaps two, *Euplœas*. I picked up the others.

Magpie Robin. *Copsychus saularis*.

25.1.09. Put a number of *Terias hecabe* (unpalatable) in the porch of my house, where the Robin comes to feed morning and evening; some had their wings removed, but it took no notice of any of them.

4.2.09. Placed 1 *T. violæ*, 1 *E. core*, 2 *T. hecabe*, and 1 *Precis lemonias* wingless, and 1 normal *T. hecabe* on the veranda. The bird ate the *Euplœa* with difficulty owing to its being very dry, and it took the body of the wingless *T. hecabe* in its bill, but dropped it almost immediately as it was too dry; it took no notice of the others.

6.2.09. Placed specimens of the above on the veranda dead but uninjured, and a wingless *T. hecabe*; the bird ate the latter but took no notice of the others.

Mr. Ormiston informs me that a Magpie Robin in his garden has become so confidential as to take food from his fingers and that it will eat "almost any kind of butterfly when thrown to it," but he has never seen it catch one. Neither have I during the seven years I have closely observed this species.

21.10.09. Put down *E. core* 5 and *D. chrysippus* 1, with the wings on one side removed. A young Magpie Robin, as shown by its speckled breast, captured one *Euplœa*, and though evidently

somewhat alarmed at its size, killed it and, after the usual difficulty with the wings, swallowed it. It immediately captured and ate a second, third, and fourth; this last was a very vigorous insect and fluttered a good deal before it succumbed. The bird was then frightened and flew away, but carried the *Euplœa* with it; it took quite another ten minutes to get rid of the wings, and during the process it twice flew off to capture small flies; it eventually swallowed it. The *D. chrysippus* was, I have no doubt, eaten by a *Calotes* which ran out of the grass close by where I had put it.

22.10.09. Put down 2 *Euplœas*, one dead and one moribund, 1 *Hypolimnas bolina* ♂ dead with wings closed, and 3 *H. misippus* ♂ alive and all lively. The young Robin immediately flew down and tackled the *Euplœa*, mangled it for some time and then dropped it and flew away; it returned shortly afterwards, picked it up and flew away with it. Directly after, another young bird flew off with and devoured the other *Euplœa*. This attracted the notice of the old birds, one of which, I think the cock, flew down, but before he could seize a butterfly was hustled off by his mate, who picked up two *H. misippus* and flew off with them. The one *H. misippus* and *H. bolina* were left.

26.10.09. Put down *H. misippus* ♂ 2, *H. bolina* ♀ 1, *Junonia (Precis) almana* 2, *Pyrameis cardui* and *Catopsilia pyranthi*, all with wings on one side removed. The *H. misippus* fluttered most and attracted the attention of *Calotes versicolor*, which pounced on and ate both of them; something then frightened it off. Next an old cock Magpie Robin caught sight of the *H. bolina*, seized and killed it after a lively chase, and finally disposed of it. It was a very long time beating off the wings and made many attempts to swallow the fly, before it was finally successful. Three or four times I thought the bird was going to leave it altogether. After swallowing the fly, it went off and drank at the runnel close by. Shortly afterwards, a young one of the same species caught sight of the *Junonia* and captured it; this disturbed *P. cardui* close by, and the bird dashed from one to the other, not able to make up its mind which to take, when the old hen bird came and tried to get one, but the youngster was too sharp for her and managed to swallow both. I should have said that this bird hopped over the *Catopsilia*, which was moribund and motionless, to seize the *Junonia*.

NOTE. I have now little doubt that so long as the butterfly is motionless, resting, as these mutilated butterflies generally do, with their wings expanded, they do not attract attention; but directly one moves, whatever the species happens to be, it is the one to be seized and eaten, even though so-called palatable species are close by. All these butterflies are flying commonly in the garden, but I have never seen them molested.

28.10.09. Put down *H. misippus* ♂ 2, *E. core* 2, *Catopsilia pyranthi* 2, *Terias hecabe* 1. The Robins came for them the moment I went off; the old cock bird seized one *Euplœa* and made off with it, and the young bird the other; this latter, after

ineffectual efforts to break off the wings, left it and caught a *Catopsilia* and ate it at once, and then the *H. misippus*, afterwards perching just above the place where I had put the butterflies. The old bird saw the *Euplexa* which had been killed by the young one and regarded it for some time, then it flew down, pecked at it, looked at it again and then flew off with it. The *T. hecabe* managed to struggle into the grass and was lost.

Curiously enough, while this was going on, a *Catopsilia pyranthi* was actually laying eggs within two feet of where I had put down these butterflies, and within twenty feet I found this afternoon eggs and larvæ of *Euplexa* on the oleander. This seems to me to show that the butterflies, when whole, are not molested because, I suppose, they are difficult to catch.

12.11.09. Put down three *H. misippus* ♂, one a partial cripple, the others with two wings off. An old hen Robin came at once, and flew off with one of the wingless ones to a bush about twenty yards off and ate it; but it did not seem very hungry. A young one a few minutes after came and took the crippled fly and ate it after the usual difficulty; it came back in a minute or two and ate the third one. The butterflies had emerged in the morning and were consequently full of juice.

16.11.09. A young Robin made off at once with a newly emerged *H. misippus* ♂.

18.11.09. Put down four mutilated recently emerged *H. misippus* ♂. The young Robin flew off with one from which the wings had been removed and ate it; a few minutes after an adult cock Robin came and ate the three others one after the other.

19.11.09. Put down four mutilated recently emerged *H. misippus* ♂ in the front garden on the drive. A *Calotes ophiomachus* ran off with one and a Brown Shrike (*Lanius cristatus*) with two others; the fourth, which had its wings only partially developed, got into the grass, grew its wings, and eventually flew off. I released three or four butterflies at the same time, and they flew off strongly enough and were not chased by the Shrike, which was sitting on a tree close by me.

21.11.09. Put down three *H. misippus* ♀ form *diocippus*, which resembles *Danaïs chrysippus*; the hen Robin came at once and ate one and flew off with another; a young bird followed its mother, and flew off and ate the other. These butterflies had hatched out that morning and the wings on one side had been cut off. I next put down five more females, all with two exceptions with the wings entirely removed. The cock bird took one of the half-winged ones and then ate a wingless one. The young bird then returned and finished off the remainder. These female butterflies evidently derived no protection from their resemblance to *D. chrysippus*, and so far as two species of birds are concerned, *H. misippus* is a palatable butterfly.

8.1.10. Found *Lycæna (Zesius) chrysomellus* ♀ fluttering on the ground; it was headless and with a piece out of one hind wing, probably caused by a Sparrow.

During this month (November 1910) I have been breeding *Hypolimnas misippus* freely, and the Magpie Robins come every morning on the chance of getting one. I have tried them with both males and females, crippled and perfect, and always with the same result. They are immediately seized, well beaten, and swallowed after considerable difficulty. I noticed on one occasion a perfect female resting on the ground with wings widely expanded but insufficiently strong to fly; the resemblance to *D. chrysippus* was perfect, but the Robin seized it without hesitation.

One day the large Hill Crow—an occasional visitant—carried off a crippled male with wings quite undeveloped; it pecked at it twice and then dropped it, shaking its head with every appearance of disgust. I remembered that the insect had fallen into and was well covered with the red liquid these butterflies always evacuate on emergence, and thinking that this was the cause of the Crow's discomfiture, I covered a crippled female with the stuff and threw it on the ground: a Magpie Robin soon came and saw it, and shook its head once or twice after pecking at it, but it swallowed it in a short time.

Mynah. *Acridotheres tristis*.

This bird belonged to Mr. O. Wickwar, F.E.S., who kindly assisted me. The bird was quite young and was allowed perfect liberty in a large garden, where it fed freely on grasshoppers and other insects; it had abundant insect food, and was also accustomed to fill up its dietary by visits to the kitchen for odd scraps. I have placed in brackets the presumed palatability or otherwise of the species experimented on.

3.1.09. Given *Euploea core* (unpalatable), took it readily, but the wings seemed to bother it considerably, so gave it another with its wings shortened, this it ate readily enough and then went back and finished off the first one. We then gave it *Papilio lankeswara* (palatable?) which was also readily eaten. Half an hour after gave *Papilio* (*Menelaides*) *hector* (unpalatable); this puzzled it for a bit and it seemed disinclined to eat it, evidently on account of the large wings, for when these were removed it ate the body with relish, even hopping off the veranda after it when it fell over the edge. A couple of *Telchinia violæ* (unpalatable) (an Acræine) ♂ and ♀ followed, and then *Hypolimnas bolina* ♀ (unpalatable?) and *Delias eucharis* (unpalatable); all these received a pinch on the head, were well pounded, wings partially removed, and the remainder eaten.

24.1.09. The bird had been kept without food for some time and was decidedly hungry. 3 *P. hector*, 1 *T. violæ*, 1 *Mycalesis ceylonica* (palatable?), and 1 *Polyommatus bætica* (palatable?) were put in a row outside the cage; when this was opened the bird hopped over them and made straight for the kitchen, where it was accustomed to pick up odds and ends. After some persuasion it ate 1 *P. bætica* and 1 *Lyccæna* (*Zesius*) *chrysomellus* ♀. Some three hours afterwards it ate 1 *Precis almana* (unpalatable),

1 *Papilio hector* and 1 *P. aristolochiæ*; it seemed a good deal worried by the wings. Afterwards neglected *M. ceylonica* and *T. violæ*, but ate one wingless *Euplaca core*.

The conclusion we arrived at from the above experiments was that butterflies were not its natural food, but that when hungry it would eat them indiscriminately, and that the palatability or otherwise of butterflies was of no account with this species of bird.

The dietary of Ceylon insectivorous birds is fairly well known, and we are now in a position to discuss the questions—Do the birds of this island eat butterflies largely? If so, do they eat them in sufficient quantity to produce any form of mimicry? and do they show any discrimination in their attacks? In other words, can the terms palatable and unpalatable as applied to butterflies be maintained.

As regards the first question, it will be granted that there is a greater destruction of butterfly life than has hitherto been supposed, and the following observation on a Bee-eater, though necessarily a rough one, shows clearly that the destruction is sufficiently severe to produce mimicry, provided of course that the agents showed sufficient discrimination in their attacks.

The road from Trincomali on the north-east coast to Anuradhapura, runs through fifty-eight miles of thick forest which is cut back some thirty paces on either side, thus affording a convenient place for butterflies which avoid the dense jungle. Between the hours of 9 A.M. and 10 A.M., I counted the number of butterflies between the third and fourth milestones from Anuradhapura, and they came to one hundred and ninety-five: the same day, in the outskirts of the town I watched a Bee-eater feeding from 12.45 to 1.45 P.M., and during this time it caught twenty insects; on only one occasion could I be certain that the capture was a butterfly, and this was undoubtedly *Catopsilia pyranthi*. The bird feeds from about eleven o'clock till five.

Motoring between these two places I calculated roughly that there was a pair of these birds to the mile*, and consequently the whole of the butterflies along this road would be cleared off in about a fortnight unless they received an accession of strength. The calculation is necessarily a rough one, but it gives a good idea of the struggle for existence that is constantly going on. This observation was made January 7th, 1909, at a time of year when butterflies are less numerous than usual.

The question whether discrimination is shown by birds in their attacks on butterflies is of the greatest importance in mimicry, and on the answer depends the fate of both Batesian and Müllerian millinery.

I do not attach much importance to the fact, curious though it is,

* Bee-eaters are particularly fond of perching on telegraph-wires.

that in the observations I have been able to collect, the Euploëines and Danaines, popularly supposed to be highly distasteful, figure more largely as victims than any other group. I believe this to be simply due to the fact that these butterflies occur in very large numbers, and not that distinct preference is shown for them. Admitting that more evidence is needed, I doubt whether future investigations will reveal any marked preference in those birds which are mainly instrumental in the destruction of butterflies, for the reason that their dietary is of such a mixed character; and if this were so, or if what I have here set forth be considered sufficient to settle the question, it is difficult to avoid the conclusion that the unpalatability of these butterflies has been assumed on insufficient data. It is interesting to recall Professor Meldola's remarks written so long ago as 1879, when Müller first propounded his theory of mimicry (Proc. Zool. Soc. Lond. 1879):—

“... it may be fairly asked how far we know that such imitated groups as *Heliconius*, *Euplœa*, *Danais*, *Acraea*, etc., are distasteful. But very few observations have, as far as I am aware, been made even upon these groups which are generally admitted to be the objects of imitation, and I certainly know of no systematic experiments conducted with these models and their insectivorous foes.”

The Bee-eaters seem to show some partiality for the yellow and white butterflies of the *Catopsilia* and *Appias* group; but whether this is more apparent than real is not clear. It may be that these butterflies are more readily seen and easier to capture than others; but if it could be proved that there is a distinct preference for them, it is noteworthy, considering the destruction that undoubtedly takes place, that though very variable they do not act as models or mimics, or form Müllerian combinations, either in India or Ceylon.

Failing the butterfly-eaters, what evidence is there that the birds of group 2, and group 3, show preference in their more or less desultory attacks? There is no doubt that those experimented on showed none, and that they took no notice of butterflies unless they were mutilated and rendered easy of capture. I should much wish to see further experiments on wild birds of these two groups undertaken, but if the butterfly-eaters do not conduce to mimicry, it is doubtful to my mind if the partial feeders would do so.

In the present state of our knowledge it is difficult to say what is or what is not an unpalatable genus, and the position is further complicated by the proposition that unpalatable species are killed in numbers sufficient to produce a special form of mimicry. It is unfortunate that theoretical considerations rather than observations and experiments in the field have hitherto preponderated in this matter. It seems to me that the terms palatable and unpalatable are not justified at present.

The Müllerian Theory.

The supporters of the Müllerian theory hold the view that it is chiefly by the attacks of the young inexperienced birds that this form of mimicry is produced. Professor Poulton puts the case as follows:—"The Müllerian theory presupposes that only *young* birds test the palatability of a few members of each convergent group in their locality and henceforward, except when driven by hunger, avoid all the members, so that the recent tendency to explain so many of the resemblances on Müllerian rather than on Batesian lines is in harmony with the conclusion that the members of such groups are not greatly attacked by adult birds." (Essays on Evolution, p. 270.)

I have already expressed the opinion that it is unlikely that young birds, except those in group 1, indulge in tasting experiments on *butterflies*, but as I am quite willing to admit that such an opinion may be founded on insufficient data, and as I was unable to find the necessary evidence required by the Müllerian theory, I approached the subject by another line of investigation, which depends on the time of the nesting of the birds and the broods of the butterflies.

The birds breed once a year, not twice as is the case in Mauritius. They begin in March or April, sometimes early in May, according to the season. When the March or April rains known as the little monsoon bring out a large increase of insect life, the birds immediately begin nesting, and the young birds are off the nest and begin to forage for themselves in May, June or early July. The average life of an insectivorous bird is probably not more than four or five years, and we may assume that tasting experiments gradually grow fewer in number and are completed when the bird is about six months old, *i. e.* about the month of October.

In estimating the number of broods of butterflies in the year, which vary much according to the species, I will direct attention to two of the more striking cases of mimicry, that of the *Eupleas*, forming a Müllerian combination, and *Papilio polytes* with its trimorphic female mimicking *P. aristolochie* and *P. (Menelaides) hector*. They may be taken together. In January, February and March, that is to say in the dry weather (I am speaking more particularly of the plains), there is a very small but continuous series of broods which depend on the weather for their development. If it is very dry, the eggs, larvæ or pupæ, as the case may be, lie dormant, but with favourable meteorological conditions such as a shower of rain, the eggs hatch, the larvæ shake off their lethargy and feed, or the butterfly emerges. Mr. Mackwood informed me that on March 24, 1908, in his garden at Colombo, eggs, larvæ and pupæ of *Eupleæ core* could be found together on the same tree. The majority of the pupæ do not, however, hatch out but remain quiescent until the April rains, when there is an astonishing outburst of butterfly and other insect life. With the onset of the south-west monsoon at the end of May or beginning

of June, the broods become larger in numbers and more frequent, and this goes on until the end of August or beginning of September, when there is a further spell of dry weather similar to but not so pronounced as that in the early part of the year, when the broods again become smaller and less frequent, but at the same time produce the individuals which take part in the migratory flights of the monsoon in November and December.

Strictly speaking, *P. hector* and *P. aristolochiae*, though following the above sequence of events, do not usually form part of the flights, but they are nevertheless at their maximum at this time; the *Euplaeas* and *Polytes* undoubtedly do so. We have now to judge what influence the inexperienced young birds off the nest in May, and their experiments concluded in October, can have on these species. A butterfly the size of *Euplaea core* pairs during its first flight, if we may judge by the cabinet condition of those ovipositing, and begins to lay its eggs three days afterwards. The usual number is about two hundred and fifty, which are deposited according to the weather in about ten days (I have known one hundred eggs laid in five days). What becomes of the parent after this? Whether she dies a natural death or becomes the victim of a tasting experiment is immaterial, her time of danger is a brief fortnight. As the females are less in evidence than the males, fewer of them would be captured, especially if we agree with Professor Poulton's opinion that the Müllerian theory presupposes that only young birds test the palatability of a few members of each convergent group in their locality. To bring to such perfection the cases of mimicry I have selected, we must assume that such a victim would be one having less converging characteristics than the others; and it must also be borne in mind that unless she is killed within three days of her emergence, she will have laid a certain number of eggs which will produce butterflies similar to herself. It is difficult to understand how the broods of butterflies, numbering some thousands of individuals, born between October and the following nesting season, would be in any way affected except in the very smallest manner. No doubt Nature is infinitely slow in her methods, and we have no reason to suppose that these cases of mimicry have been produced, otherwise than by a very lengthy process of weeding out; but even if we grant this, there is a still greater difficulty in the case of *Hypolimnias misippus*, the well known mimic of *Danaus chrysippus*. In Ceylon the former appears on the wing in October, when as I have said tasting experiments are over. It remains on the wing until the end of the year, when it disappears until the following autumn. There are so far as I can see only two ways of getting over this difficulty—either by assuming that the inherited tendency to produce this form of mimicry has become so fixed that the withdrawal of the factor that produced it is immaterial, though there is no reason for this supposition, or that there is a more or less constant influx of the species from India. There is very little doubt that a certain number of Ceylon butterflies in their annual migratory flights

find their way to India, but I can find no evidence of a reverse condition of things, and one can scarcely credit that the few chance stragglers which possibly find their way across the sea could keep up this perfection of mimicry in the south of the island. The supposition that the sudden appearance of a previously unknown species would produce further tasting experiments will not hold good in this case, as the mimic so closely resembles its model *D. chrysippus*, which is on the wing all the year round.

Experiments on Young Birds in Confinement.

I am extremely doubtful as to any real value accruing from experiments on caged birds, whether nestlings or adult. No one, I imagine, believes that all butterflies taste alike: no doubt some are more tasty than others, and caged birds fed upon butterflies even with other insect food would no doubt learn in time to distinguish the different kinds; but this procedure to my mind begs the question, as it assumes that butterflies are an ordinary article of food in the wild state, a proposition regarding which the evidence here brought forward does not altogether support. The case is different with Coleoptera, Hemiptera, Diptera and the like, which are known to be the staple food of birds. Lloyd Morgan's carefully conducted experiments leave no doubt that certain species of birds, probably all, have very little instinct as to what is good, and what not, and that they learn by imitation and tasting experiments. My observations lead me to believe that the former is very important. I briefly epitomize my own conclusions.

1. Young birds probably learn at first in a general way what is their natural provender by what is brought to them in the nest.

2. That this is further developed when they have left the nest but are too weak to accompany the parents when they are foraging for food.

3. That when they accompany the parents, as they do for a longer or shorter time according to the species, they notice the insects caught and attempt to capture them themselves.

4. When they are left to shift for themselves they carry on what they have learnt, and during this time they undertake tasting experiments, but with the exception of the birds in group 1, those on butterflies are few in number; first, because they have rarely or never had butterflies brought to them in the nest; secondly, because they have very rarely seen their parents catching them, and so neglect them; thirdly, because they have considerable difficulty in catching them, and the process of getting rid of the wings is tedious and lengthy and the morsel fluffy, and possibly not always agreeable. If these observations are confirmed by further experience, they would account for the fact that attacks on butterflies are less frequent than those on other insects.

Instances of Imitation by Young Crows.

July, 1910. I saw an old crow and two young ones on the Rifle Green this morning; one of the youngsters had hold of a bone with a piece of gristle attached to it. It was so firmly adherent that the bird could not detach it as the bone constantly moved with the bird's efforts, and eventually it gave up. Then the old bird, which had been standing by all the time, went to the bone, put its foot on it, thereby gaining a purchase, and tore off the gristle without difficulty; the young bird after two or three attempts did the same.

September, 1910. An old crow had a piece of hard boiled potato off which it was picking pieces and giving them to a full-fledged young one close by. A goodly number of detached pieces lay on the ground and attracted the attention of some other crows, which flew down and began picking them up; seeing this the youngster did likewise, though it made no attempt to do so before their arrival.

Seasonal Dimorphism—Cryptic Defence.

I should not conclude this study of mimicry without discussing that form of it which is known as "cryptic defence," and especially that which is so noticeable in the seasonal changes of so many tropical butterflies.

It is commonly believed to have been produced by natural selection acting through the medium of insectivorous foes, the more exact and perfect imitations found in the dry season being due to the paucity of insect life at that time of the year, which produces a greater keenness in pursuit and a greater struggle for existence. The argument has been put forward in full by Professor Poulton in his 'Essays on Evolution,' page 203.

I hope in the near future to deal more exhaustively with this subject, but at present will only direct attention to two species occurring in these islands, a study of which does not favour the usually accepted views. The contention for the production of the dry season form rests upon the premiss that "the dry season is a time of far greater pressure than the wet"; for although the enemies of insects are fewer, the insects themselves are proportionately even more reduced, and "the light thrown by recent investigation leads us confidently to believe that the differences between the seasonal forms—hitherto devoid of interpretation—have a meaning and a value in the struggle for existence and came into being under the sway of natural selection" (Poulton).

Though it is probably correct to say that in countries such as S. Africa and India, which have a continental climate, the seasons are such as to produce a wealth or poverty of insect life, it is decidedly incorrect to assume the same with regard to the islands we have been investigating. There is no doubt that at no season of the year is there in any of them a paucity of insect life, and at

no time would an insectivorous bird, or reptile, find any difficulty in procuring its daily sustenance.

Bourbon and Mauritius are very largely under sugar cultivation, and this necessitates constant manuring of the fields, with a consequent abundance or superabundance of flies of all sorts throughout the year. The rainfall, though greater in the wet season, is not infrequent during the dry season, and this also favours insect life; and if we add to this the consideration of the practical absence of butterfly-eating birds and reptiles, we can estimate the difficulty of believing that these changes are the outcome of natural selection in these two islands.

In Ceylon Mr. E. Ernest Green, who has lived thirty years in the island and who knows every part of it, writes as follows:—

“Though insects are more abundant at certain seasons, I have never experienced any part of Ceylon where there was anything approaching a dearth of them. I know that I am always busy pinning and setting throughout the year.

“I sometimes wish that there *was* a short dead season, when one could devote oneself to other work without being distracted by the constant accumulation of material.

“I doubt if *Melanitis* is ever subject to much worry from birds. It lives in the shade and never moves during the daytime, unless flushed by some big animal. I am now receiving (16.8.10) both dry and wet season forms of *M. tambra* from Kandy.”

An allied species *Melanitis leda* occurs also in Bourbon and Mauritius, and it is to be remarked that the dry season forms begin to appear before the advent of the dry season, that is to say before any form of stress would tend to make itself felt.

In explanation, it may be suggested that the butterfly was introduced from the locality where natural selection produced these changes and that it is simply carrying on an inherited tendency. That it is an introduced species is highly probable, but it has been known to entomologists in Bourbon and Mauritius for at least sixty years, and it differs in no way now than in the time of Boissduval. It is difficult to believe that the factor which produced this cryptic defence being removed and no longer required would not have led to some other form of colouring, or a return to that ancestral type from which these forms were evolved. The above remarks apply equally to *Mycalesis narcissus*, *Precis rhadama* (introduced 1858), and *Terias floricola*, and I have made a further study of *Terias hecabe* in Ceylon. It is very frequently the case that the wet form continues to appear well into the dry weather and *vice versa*, but to a less extent; this has been remarked on frequently, but so far as I know no exact observations have been made. In Colombo there was no rain from November 19th till December 10th, 1908, thence to January 6th, 1909, .70 of an inch, but of this no less than .57 fell on one day (Dec. 19th); such an absence of rain in a tropical country at once causes a general drying up of vegetation and the assumption of dry weather conditions. At weekly intervals I captured all the *Terias* I could, which were

accustomed to breed on a hedge of Madras thorn in an isolated position in my garden; the results of such counts showed 73 wet forms, 1 intermediate, and 19 dry, and it was not until January 28th that the wet forms were entirely replaced.

The butterfly takes exactly a fortnight to pass from larva to imago, and thus we have approximately three or four broods of wet season forms produced under dry season conditions. We must assume that as the butterfly is seasonally dimorphic it stands in need of protection, yet so far as I could ascertain the wet forms suffered no diminution though exposed to what were, or should have been, adverse circumstances.

The butterflies rested during the night and in cloudy weather on the under surfaces of the leaves of *Vincta* sp.?, a small flowering shrub with pink flowers and small oval green or frequently yellow faded leaves. It often collected gregariously, two or even three being on the same leaf and perhaps ten on the same plant. The position was an admirable one for protection from the wet, and also from small predatory foes which seldom look upwards when hunting for prey. The appearance of the plant is the same throughout the year, and the butterfly derived no advantage from its change from one seasonal form to the other.

The following experiment makes me still further doubtful of these effects being due to natural selection.

If we take the pupa of a somewhat similarly coloured butterfly which is not seasonally dimorphic, such as *Papilio demodocus* or *Papilio demoleus*, and expose it to a hot dry temperature, we can produce an insect with much of the yellow on the under surface replaced by red. I am almost persuaded that these rusty red spots are a vestige of a character at one time common to certain Pierines and Papilionines which is more or less reproduced by heat and dryness, if of sufficient duration and intensity under natural conditions in the Pierines, but in the Papilionines only under artificial stimulation of a like but exaggerated character.

CONCLUSIONS.

1. It has been shown that in Bourbon and Mauritius there are no butterfly-eating birds or reptiles; so that the cases of mimicry occurring there cannot be due to their influence.

2. In Ceylon it has been conclusively shown that the butterfly-eating reptiles are impartial feeders.

3. That a trained observer can distinguish the majority of these mimetic butterflies at a distance of about twenty or thirty feet and frequently at the same number of yards; and this being so, it is certain that a bird which has to depend for its existence on its powers of observation, could after a few failures be able to discriminate them at the same and probably at a considerable greater distance.

4. That Drongos feed largely upon Euplocas, and this being so,

a *Papilio* mimicking them obtains no protection in the vicinity of these birds.

5. There is no bird in Ceylon known to eat butterflies that distinctly discriminates as an adult between one species of butterfly and another.

6. It has been shown that there is a great destruction of butterfly life in the dry zone, and that here, if anywhere, Müllerian or Batesian mimicry might be induced, but the destroyers are largely migratory and their attacks are not selective.

7. That the number of broods of butterflies which occur between the termination of tasting experiments in one year and the commencement of them in the next is so great that any influence which could be wrought by such is almost inappreciable.

8. The little evidence available shows that young Ceylon birds imitate their parents in their choice of food; but as regards butterflies, the fact that there is no discrimination shown by adults leads one to conclude either that few or no tasting experiments were undertaken in youth, or, what is more probable, that their taste with regard to them is indifferent.

9. It is questionable, and so far as an accurate knowledge of one species goes it is definitely shown, that that form of mimicry represented by wet and dry season forms (cryptic defence) is not produced for the protection of the species, inasmuch as many (four) succeeding broods of the wet weather form may be found under dry season conditions without detriment to the species.

34. The Distribution of the Avian Genus *Megapodius* in the Pacific Islands. By J. J. LISTER, M.A., F.R.S., F.L.S., F.Z.S.

[Received and Read May 9, 1911.]

(Text-figure 166.)

The Megapodiidæ or Mound Builders are, as is well known, large birds, with comparatively feeble powers of flight, constituting a family of the order Gallinæ. They are distributed over the islands of the East Indian Archipelago and Western Pacific, from the Philippines and Borneo to the New Hebrides, and are found in several parts of the continent of Australia. Four outlying species of the genus *Megapodius* are found in the Nicobar, the Pelew, and the Marianne Islands, and, far out in the Pacific, on the little island of Niuafoou, belonging to the Tongan group.

As we cannot suppose that the birds found in these outlying islands, remote from the other species, can have flown across the intervening tracts of ocean, we are presented with the problem: How did they reach these islands?

The solution to which M. Oustalet gives his adhesion, in his Proc. Zool. Soc.—1911, No. LII,

monograph on the Family*, is that all these localities have been at one time connected by land, which has since been to a large extent submerged.

Text-fig. 166.

Map illustrating the Distribution of the Genus *Megapodius*.

Wallace had, in 1876 †, expressed the opinion that the *Megapode*

* "Monographie des Oiseaux de la famille des *Mégapodiidés*," Ann. d. Sciences naturelles, 6 sér. t. 10 & 11, 1880-81.

† Geographical Distribution of Animals. London, vol. ii. p. 342.

of the Nicobar Islands had probably been introduced by the Malays, but Oustalet cannot regard this explanation as plausible, on the ground that "we possess no positive proof of the domestication of Megapodes by the Malays or the savage people inhabiting the Oceanic Islands."

My object in this paper is to point out the reasons which appear to me to make it probable that the distribution of the genus *Megapodius* has been, as Wallace suggested in the case of the Nicobar bird, considerably modified by human agency; and that the species found in these outlying Pacific islands have been carried there by man.

Since Oustalet published his monograph the Megapodiidæ have been again reviewed by Ogilvie-Grant in his Catalogue of the Game Birds in the British Museum*; and in 1901 Rothschild and Hartert† gave their revision of a portion of the genus *Megapodius*.

The determination of the limits of the species of this genus is difficult on account of the variation in size and colour presented by the birds inhabiting the same locality, and the fact that the characters of those from different localities often merge into one another. On comparing the results arrived at by the authors mentioned, we find that nineteen species were enumerated by Oustalet. If we take from these *M. wallacei*, which has been placed by Ogilvie-Grant in a separate genus (*Eulipoa*), and *M. brenchleyi* and *M. brazieri*, which had then been described only from eggs or young birds, there remain sixteen species. Five of these are united in two species by Ogilvie-Grant, and seven which inhabit the area dealt with by Rothschild and Hartert are allowed by these authors only subspecific rank under two specific names. On the other hand, the species *M. macgillivrayi*, which is united by Oustalet with the widely extended *M. duperreyi*, and regarded as only a subspecies by Rothschild and Hartert, is reckoned a distinct species by Ogilvie-Grant.

The peculiar nesting habits of the Megapodiidæ are well known. Most of the species scrape together large mounds of earth or sand, with or without vegetable matter, and the female deposits her eggs, which are very large for the size of the bird, at intervals of several days, in excavations in these mounds. Incubation is effected by the heat of the slowly fermenting mass, aided by that of the sun, or by the sun alone; and the young are hatched in an advanced state of plumage. They receive no attention from their parents, and in some cases at least they are able to fly on the day on which they are hatched. In some species many pairs of birds frequent the same mounds or laying-grounds.

In almost all the countries where Megapodes occur, their large eggs are highly valued by the natives as food, and their laying-places are frequently visited for the purpose of obtaining them.

* Catalogue, Vol. xxii. 1893. Also 'Game Birds': Allen's Naturalists' Library, London, 1895-7.

† "Notes on Papuan Birds." Novitates Zoologicæ, vol. viii. p. 135, 1901.

There is clear evidence that the birds are at least semi-domesticated in some localities.

Mr. C. M. Woodford*, speaking of *M. breuchleyi* (*M. eremita* of B. M. Catalogue) on Guadalcanar, in the Solomon Islands, says: "The birds lay in open sandy clearings, generally near the sea, which are kept clear of shrubs and undergrowth by the natives, and by the sand being constantly turned over by the birds Many thousands of birds congregate at the same place, the laying-yards being often some acres in extent." Of the little island of Savo, to the north of Guadalcanar, the same author writes†: "although only about the size of a large pigeon" the megapode "lays an egg bigger than that of a duck," and "eggs form an important item in the daily food-supply of the natives." "The megapodes lay their eggs on two large cleared sandy spaces and nowhere else on the island. Upon these no weeds or grass can grow as the ground is constantly being turned over by the birds when digging holes to lay their eggs, and by the natives when in search of them. The sandy spaces are fenced off in plots which belong to different owners." He adds that the natives are quite indifferent as to the condition of the eggs when they eat them, it is all the same to them whether they are newly laid or well advanced towards hatching.

Mr. John Brazier, writing of a collection of eggs of Megapodes exhibited before the Society: says‡. "When at San Christoval" (in the Solomon Islands) "I was shown an egg that Perry, a white man living there these last five years, said was laid by the 'Wild Fowl,' and upon my visiting him a few days later, he had just obtained another from the nest of his domestic fowls."

M. Freycinet, in his narrative of the voyage of the *Uranie*§, says of the species which was discovered by this expedition on the Marianne Islands: "Espèce de gallinacée de couloir noir que jadis les anciens Mariannais élévoient auprès de leurs cabanes; elle est aujourd'hui fort rare. Nos naturalistes lui ont donné le nom de Mégapode la Pérouse."

In the volume on Zoology (p. 125) of the same work the naturalists Quoy and Gaimard say of *M. freycineti*, which they discovered on the island of Waigiou, to the west of New Guinea, and which is now known to occur from the Moluccas to Western New Guinea: "Sur les îles Vaigiou et Boni, ces oiseaux paroissent vivre dans une demi-domesticité, à-peu-près comme les canards qui habitent les marais que traverse la petite rivière de Sèvre, (Charente Inférieure)." One, brought by the natives, lived several days on the *Uranie*.

Professor J. Stanley Gardiner, whose investigations of the Fauna and Flora of the Maldive and Laccadive Islands are well

* The Naturalist among the Head-hunters, pp. 100-101.

† P. Z. S. 1888, pp. 249 & 250.

‡ P. Z. S. 1874, p. 607.

§ Voyage autour du Monde sur les corvettes de S.M. l'*Uranie* et la *Physicienne*. 1817-1820. Paris. 1825.

known, informs me that a sultan of the Maldivé Islands, who died in 1878, introduced Megapodes into an islet covered with cocoanuts and scrub, forming part of the great atoll of Malé in that Archipelago. Where these were obtained is not known, but Professor Gardiner thinks it probable that they were imported from the Nicobar Islands, between which group and the Maldives there is regular trade communication.

We have thus from four widely separated localities definite evidence of the more or less complete domestication of Megapodes by the natives. Finally Guillemard *, referring to Wallace's view that the Nicobar Island bird was introduced, says "that this is not impossible must be evident to every traveller in the Malay Archipelago, for birds of this genus are often seen in captivity."

With regard to the powers of flight of Megapodes, they are compared by some authors with those of barn-door poultry. Oustalet, however, recalls the fact † that a young specimen of *M. freycineti* flew on board 'La Coquille,' with a favouring breeze, when that vessel was "plus de deux milles" (over two miles) from land.

Le Souef ‡ mentions that *M. duperreyi*, although the birds are "very poor fliers," occurs on the scrub-covered islands "a good many miles" from the N.E. coast of Queensland. He surmises that they may have been blown out during cyclones.

Finsch § speaks of *M. senex*, the species inhabiting the Pelew Islands, as occurring on nearly all the sandy and rocky islands of the group. Some of these are separated by intervals of some three or four miles. He considers that the bird, "which is a good flier" (the term is of course used in a relative sense), may occasionally fly from one island to the other. He also mentions that the eggs are systematically taken by the natives.

But when all allowance is made for their powers of flight, it would seem an extravagant suggestion, and one which I think has never been made, that Megapodes could by this means have reached the outlying islands in which they are now found. The Pelew Islands are separated by nearly five hundred miles from the Philippines, the nearest land to the west, and by a rather greater distance from New Guinea to the south. The Marianne Islands are some 600 miles to the E.N.E. of the Pelew Islands. Niuafoou is nearly 1000 miles to the east of the New Hebrides, the nearest islands to it on which a species of Megapode exists.

We may now examine the geological nature and some other conditions of these outlying islands in the Pacific on which Megapodes are found, as well as the characters of the species living on them.

The island of Niuafoou, or New Hope Island, although politically part of the Tonga group, is situated almost halfway between

* Cruise of the Marchesa, vol. ii. p. 122 (footnote), 1886.

† *L. c.* vol. xi. p. 69.

‡ *Ibis*, 1899, p. 16.

§ "Die Vögel der Palau-Gruppe." *Journal des Museum Godeffroy*, Heft viii. Bd. iii.) 1875, p. 30 (p. 162 of the volume).

the Fiji and Samoa Islands. It is described in Findlay's South Pacific Directory* as a volcanic island with black lava rocks all round the shores. It is 3 to $3\frac{1}{2}$ miles across, well wooded, and some 500 to 600 ft. high. In the centre is a brackish-water lake at sea-level in which are hot springs. Friedländer†, who visited the island in 1897, describes his visit to the nesting places of the birds, which are on the shores of this lake. He had to swim round some of the rocky points to reach them, and found the temperature of the water that of a warm bath, and the rocks under water too hot, in places, to rest his hands on them. He says the island is an intermittently active crater, largely composed of basaltic rock. An eruption occurred in 1886, when the whole island was covered with ashes, and the Megapodes were nearly exterminated. Owing to the 'tabu' imposed by the chief their numbers had increased again, so that there was a fair number at the time of his visit. The birds do not build mounds, as do many of their congeners, but lay in holes which they excavate in the volcanic sand. He is inclined to attribute the heat of the sand, which he found on digging for the eggs, to the volcanic action. We may note in passing that P. & F. Sarasin‡ found that the Maleo (*Megacephalon maleo*) of Celebes lays in the neighbourhood of hot springs, as well as on the sea-shore.

The birds of Niuaufou were collected by Mr. F. Hübner and described by Dr. Finsch§. With the exception of the Megapode all belong to common Tongan species, but Finsch remarks on the absence from the collection of four species (*Ptilotis carunculata*, *Halcyon sacra*, *Lalage maculosa*, and *Colluricincla heinei*) which besides being common in Tonga are present, or represented by allied species, in Samoa and Fiji. At first sight it would appear that the absence of these species from Niuaufou might be attributed to the destructive eruptions of the volcano, but as these species are unrecorded from the not very distant group of Uvea (Wallis Id.), their absence from Niuaufou cannot certainly be attributed to that cause. It must be admitted, however, that a small volcano, still in intermittent activity, is the last place on which the remnants of an ancient fauna would be expected to survive. Had the bird been found on the high and ancient land masses of Fiji or Samoa, the case against this view would not have been so strong, but the birds of these islands have now been so fully collected as to make it in the highest degree unlikely that so large and useful a bird as a Megapode should have been overlooked in them.

The Niuaufou species, *Megapodius pritchardi*, was described by the late Sir Walter Buller|| in his Supplement|| to the 'Birds of New Zealand,' and included, under the name of "The Southern

* 3rd edition, p. 558.

† "Ueber die Nestlöcher d. *Megapodius pritchardii* auf der Insel Niuaufou." Ornithologische Monatsberichte, vii. p. 37, Berlin, 1899.

‡ Zeits. d. Gesellschaft f. Erdkunde, Berlin, 1894, pp. 375, 388, 396 & 398.

§ Z. S. 1877, p. 782.

|| Vol. i. p. 31.

Megapode," in that fauna—on what appear to be wholly inadequate grounds.

In 1887, Mr. T. F. Cheeseman, the well-known Curator of the Auckland Museum, to whose knowledge and kindness many visitors to New Zealand are indebted, visited the Kermadec Islands, which are a scattered group lying nearly halfway between the North Island of New Zealand and the Tonga Islands to the N.N.E., and some 400 or 500 miles from either. Mr. Cheeseman reported * that a Mr. Johnson, who had resided on Sunday Island (a volcanic island, the most northerly of the group) about fifteen years before, told him that "prior to the eruption of 1876 a bird inhabited the floor of the large crater, which made mounds of sand and decayed leaves, two to three feet high, laying its eggs in the mounds. He was in the habit of visiting the mounds for the sake of the eggs and young birds, and has frequently taken 5 or 6 of the latter from the same nest at one time." The eruption of 1876 covered the floor of the crater and apparently killed out the species. Mr. Cheeseman cautiously observes that the evidence, such as it is, seems to point to the former existence of a species of *Megapodius* on this island.

We may remark that the statement that five or six young birds were taken from the same nest at one time is hardly in accordance with the habits of the genus, for the eggs being laid at some intervals the young ones are not of the same age, and leave the mounds to feed for themselves soon after they are hatched. The statement would be more appropriate to the young of the Grey Duck (*Anas superciliosa*) which frequents this island. It is the mound-building habit which, as Mr. Cheeseman says, "seems to point" to the existence of a Megapode on Sunday Island.

Sir Walter Buller † on the strength of this evidence includes *Megapodius pritchardi* among the birds of New Zealand, in which region the Kermadec Islands are included. He says: "I have no doubt whatever in my mind—notwithstanding the apparent difference in their nesting habits—that Mr. Cheeseman was right in his conjecture" that the Sunday Id. and Niuafoou birds were identical. (It will be noted that Mr. Cheeseman conjectured that the genus, not the species, was identical.) On the discrepancy that whereas the Niuafoou bird lays in burrows, the Sunday Id. bird is stated to have built mounds of sand and leaves two to three feet high, he remarks (p. 33): "If the latter observation was accurate it may have been due to circumstances of locality and environment, and by no means negatives the assumption of these birds being one and the same species." As we have seen, the statement that the Sunday Island bird built mounds is the only evidence we have of the existence of a Megapode on that island.

Through the kindness of Mr. Ogilvie-Grant I have had the good

* "On the Birds of the Kermadec Islands." Trans. and Proc. of the N. Zealand Institute, vol. xxiii. (1890) p. 219.

† Supplement to the Birds of New Zealand, vol. i. (1905) p. 31.

fortune to meet at the Natural History Museum Mr. Iredale, who has recently resided on the Kermadecs with the object of studying their fauna. He assures me that he was not able to obtain any confirmation of the report of the existence of a Megapode on Sunday Island which was given to Mr. Cheeseman, and finds that the successors of his informant are not inclined to regard that report as worthy of very serious consideration.

It therefore seems to me that we have no good evidence that the genus *Megapodius* formerly inhabited the Kermadec Islands and absolutely none that *M. pritchardi* lived there.

One good result, however, we owe to Sir Walter Buller's enthusiasm in claiming this species as a member of the New Zealand fauna, and that is a plate representing the bird in a condition of plumage not hitherto figured.

M. pritchardi belongs to the section of the genus with the back and upper surface of the wings rufous brown, the breast and belly lead or slaty grey, and in its general coloration perhaps is nearest *M. cumingi*, Dillw., of the Philippines and Borneo. In the type specimen described and figured by G. R. Gray*, and now in a somewhat dilapidated condition in the British Museum, the bases of the quill-feathers, except the first, are white; there is also some white among the upper tail-coverts. A specimen in the Leyden Museum was described by Schlegel† (and I have had an opportunity of examining it) which has, as he observes, the upper tail-coverts pure white. The first specimen which came to the Auckland Museum was described by Buller‡. It had no white on either quill-feathers or tail-coverts, though the rectrices were white at the base§. As it was not known then that this skin came from the same locality as *M. pritchardi*, and it differed so considerably from the type of that species, it was described by Buller as a new species—*M. huttoni*.

Buller's plate (pl. ii.) in the Supplement to the 'Birds of New Zealand' shows no white in the plumage. In the description he says (p. 32):—"Although absent in this specimen" (that named *M. huttoni* and perhaps the specimen figured in the plate) "most examples have a patch of white covering the basal parts of the primaries and secondaries, the extent varying in almost every individual. Some also have white markings on the upper tail-coverts and basal part of the tail-feathers."

It appears then that the feature by which *M. pritchardi* stands apart from all other species of the genus—the occurrence of white at the bases of the primaries and elsewhere—is a varying and inconstant character.

To return to the comparison with *M. cumingi*, I find that *M. pritchardi* has the top of the head slaty-brown rather than brown, the sides of the head rather paler, the mantle brown tinged with slate rather than olive-brown, and the belly a paler brown.

* P. Z. S. 1864, p. 41, pl. vi.

† Mus. Pays-Bas, viii. p. 64.

‡ Transactions of the N. Zealand Institute, vol. iii. (1870) p. 14.

§ Hutton, Trans. N. Zealand Institute, iv. (1871) p. 165.

We may note that the species inhabiting the New Hebrides, *M. layardi*, belongs to the group of species having the mantle and upper parts blackish grey, not rufous brown as in *M. pritchardi*.

There is one other fact which seems to point to the view that the Ninafou bird is not indigenous to that island, viz., that the native name, *Malow*, is the same as that applied to several species of Megapodiidae in the Malay Archipelago. This appears in the specific name of *Megacephalon maleo* of Celebes. *Megapodius cumingi* is called *moleo kitjil* (= little moleo) by the natives of that island, in distinction, probably, from the larger *Megacephalon maleo**. *M. layardi* is the *Malow* of the natives of the New Hebrides. Oustalet says that this name appears to be applied indifferently to Megapodes by Malay hunters. Its occurrence on Ninafou, far out in the Pacific among a population of Polynesian speech, seems to suggest strongly that at some time the name arrived at the island with the bird.

With regard to the Marianne and Pelew Islands, I have less evidence to bring forward, but it was in the former group that Quoy and Gaimard were told that the Megapode (*M. laперousii*) had been domesticated. It is so closely similar to *M. senex* from the Pelew Islands that M. Oustalet has regarded them as of the same species†.

The geological structure of the Pelew Islands is discussed by Semper‡, who shows that the islands are composed in part of raised coral, in part of volcanic rock, formed during submarine eruptions. If this is the case, there can be no remains on the Pelew Islands of the fauna of a subsided land-mass, supposing such a mass to have existed.

From the description of the Marianne Islands in the account of the Voyage of the Uranie, above quoted, it is stated (Historique, T. 2, p. 253) that they seem to have been formed in the remote past by submarine eruptions, which have raised the floor of the ocean, and that the reefs which have formed about the islands as they have risen above the waves have since been raised with them. So that it would appear that the same remark is applicable to these as to the Pelew Islands.

M. laперousii and *M. senex* have the upper parts blackish grey, as have *M. freycineti*, from the Moluccas and New Guinea, *M. geelinkianus* from New Guinea and some adjacent islands, and *M. layardi* from the New Hebrides. But they differ from these and other species in the french-grey colour of the feathers of the head. We must conclude therefore that this character has been developed since their isolation, or else that the parent stock has either not yet been discovered, or has become extinct.

In the British Museum Catalogue three "doubtful species"

* Meyer & Wieglesworth, Birds of Celebes, vol. ii. 1895, p. 671.

† Cf. Oudrie-Grant, Allen's Naturalists' Library: Game Birds, vol. ii. p. 182.

‡ The Natural Conditions of Existence as they affect Animal Life, by Karl Semper, Chapter 8: International Scientific Series, vol. xxxi. London 1883, pp. 234 & 264.

are mentioned (p. 446) by Ogilvie-Grant, viz.: 1. Young birds said to have been obtained on Lord Howe's Island; 2. The Megapode of Sunday Island in the Kermadec group; and 3. *M. ? andersoni* of Gray from New Caledonia. The first of these Mr. Ogilvie-Grant assures me is now known to have come not from Lord Howe's Island, but from New Hope Island, another name for Niuafoou. With the second I have already dealt. The third is based on a reference in the MS. of Anderson, who accompanied Cook's third voyage, to a bird he called *Tetrao australis* and briefly described as follows:—"fusca nigraque; pedibus nudis." The subsequent exploration of New Caledonia has not revealed the presence of a Megapode on that island.

To sum up: There is evidence of the domestication or semi-domestication of Megapodes in several parts of the area they inhabit,—viz., in the Solomon Islands, Western New Guinea and the Marianne Islands, and of their introduction into the Maldivé Islands. There is no satisfactory evidence that a Megapode has ever existed on any Pacific island east of a line bordering the Philippines, Solomon Islands, and New Hebrides except the Pelews, Marianne Islands, and Niuafoou. The geological character of these islands, so far as we know it, lends no support to the view that they could preserve the fauna of a sunken land-mass. The birds of the Pelew and Marianne Islands are almost identical, and on the latter group they were domesticated. The bird of Niuafoou is called by a Malay name.

When we consider the complex movements of the races of the Western Pacific, of which there is much anthropological evidence, and how easily Megapodes might be introduced into a new locality by a canoe provisioned with their eggs, which are a staple native food, it would appear that we have in human agency a probable key to some of the anomalies of their distribution.

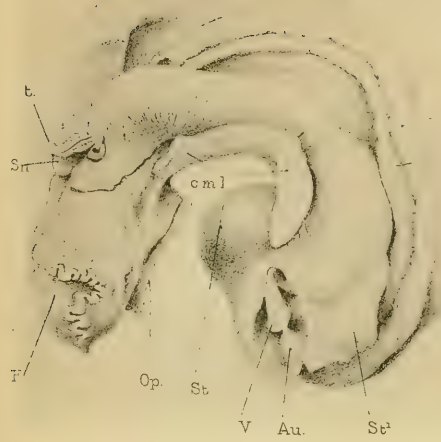
The analogy of the distribution by native agency of domestic fowls, cousins of the Megapodiidæ, and of the dogs and pigs which were found by the early voyagers on the Pacific Islands, is obvious.

How far the same cause may have been operative within the main area occupied by the genus, and have given rise to the anomalies in the distribution of the species alluded to by Oustalet, is too large and complex a subject for me to attempt to deal with.

The Savo natives, says Mr. Woodford,* speaking of *M. eremita* of the Solomon Islands, have a curious legend connected with this bird. They hold the Shark in great veneration and say that their island was made by the Shark, who brought stones together and placed upon them a man, a woman, the Yam plant, and the Megapodes. Things went well for a time and the people increased and so did the Megapodes. At last the people went to the Shark and complained that the Megapodes made havoc among the yam

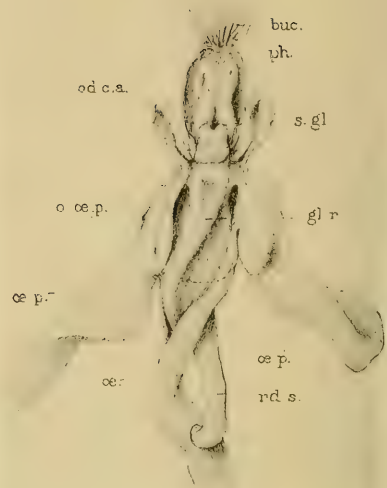
* C. M. Woodford, P. Z. S. 1888, p. 249.

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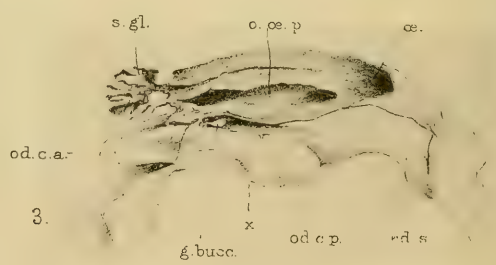
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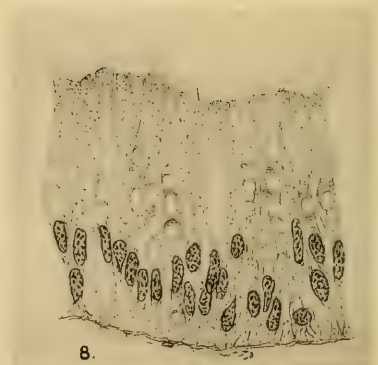
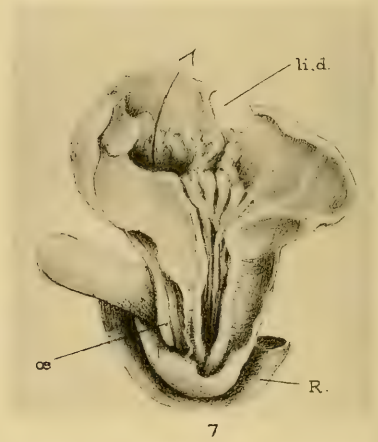
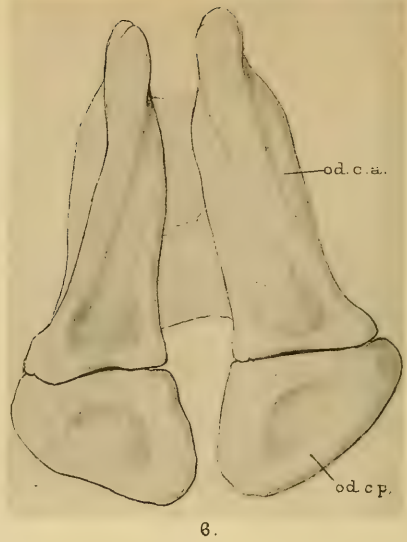
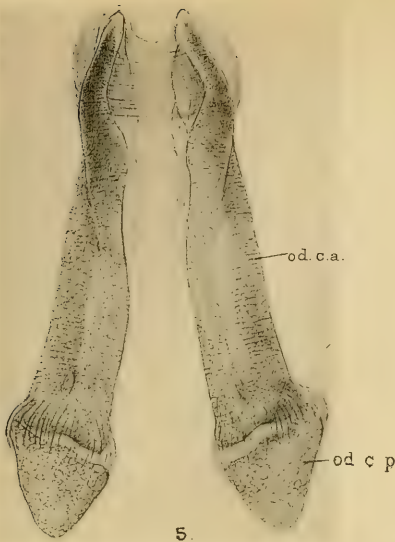


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G.C.Bourne.

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MORPHOLOGY OF THE HELICINIDÆ.





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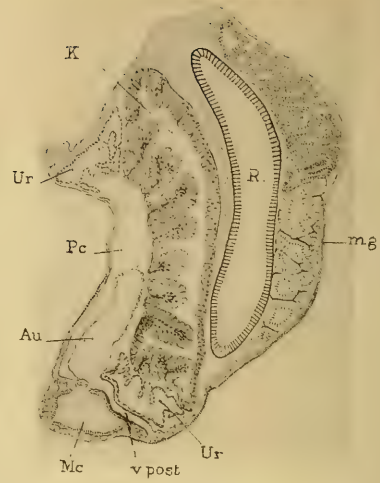


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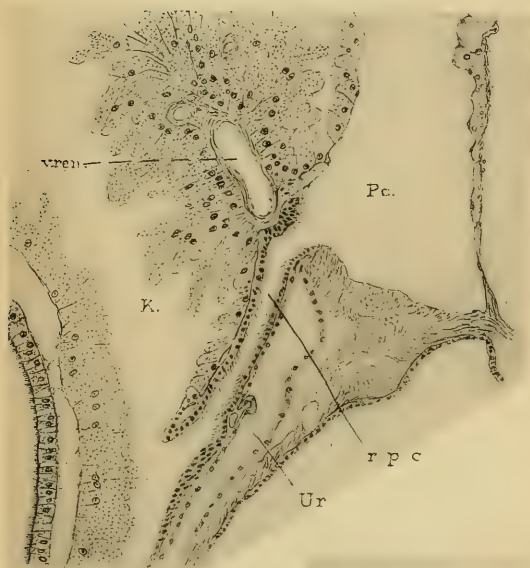
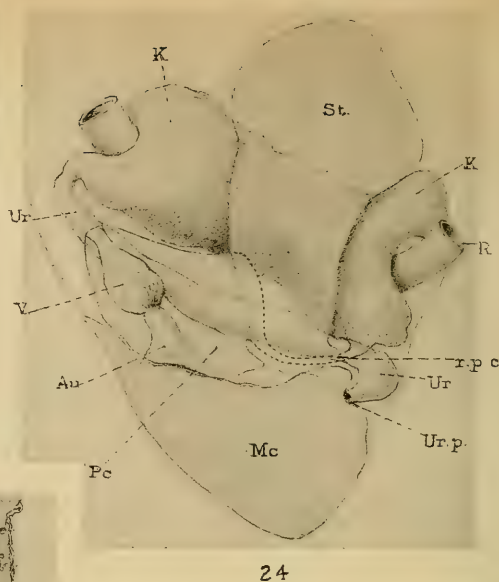
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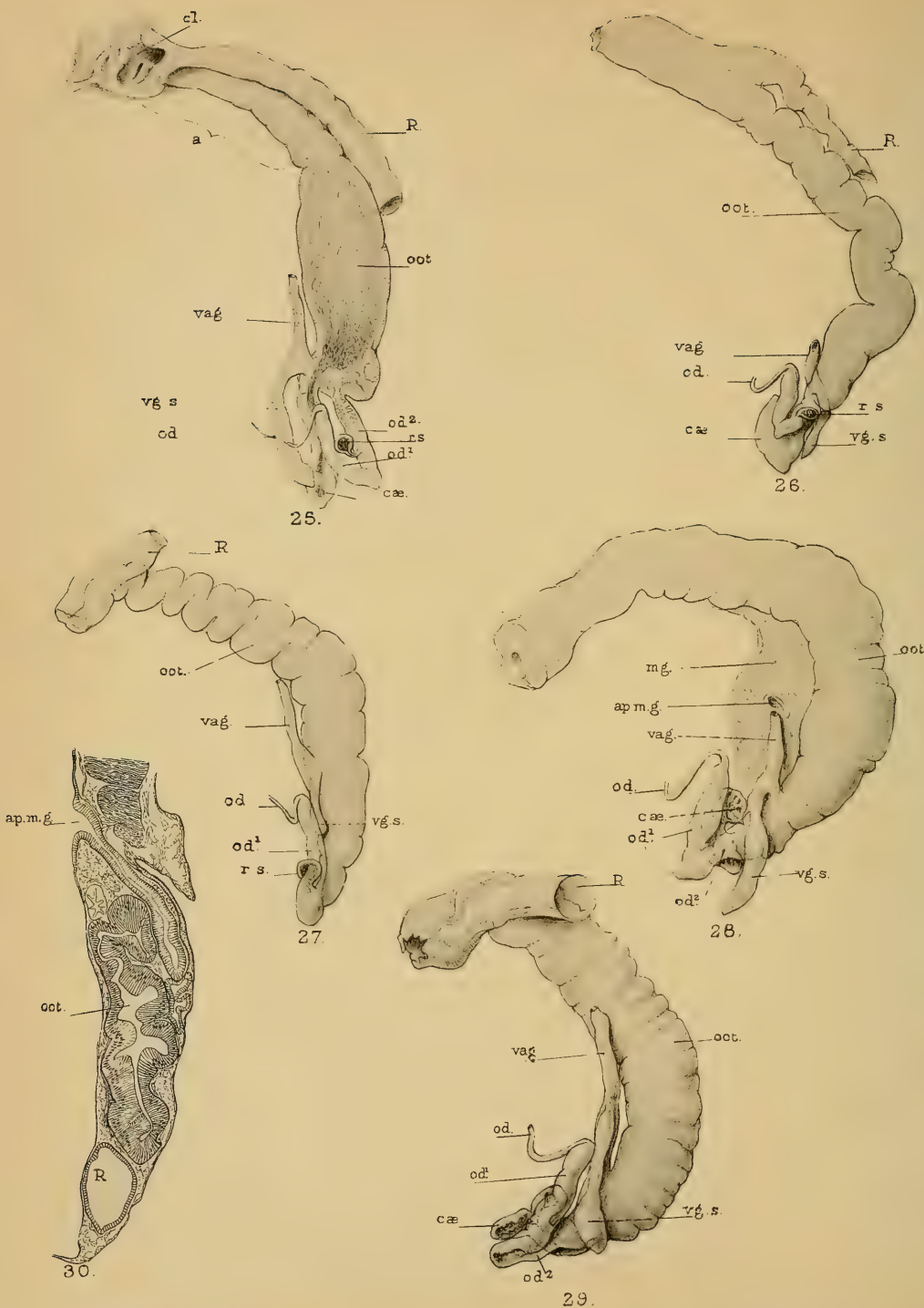


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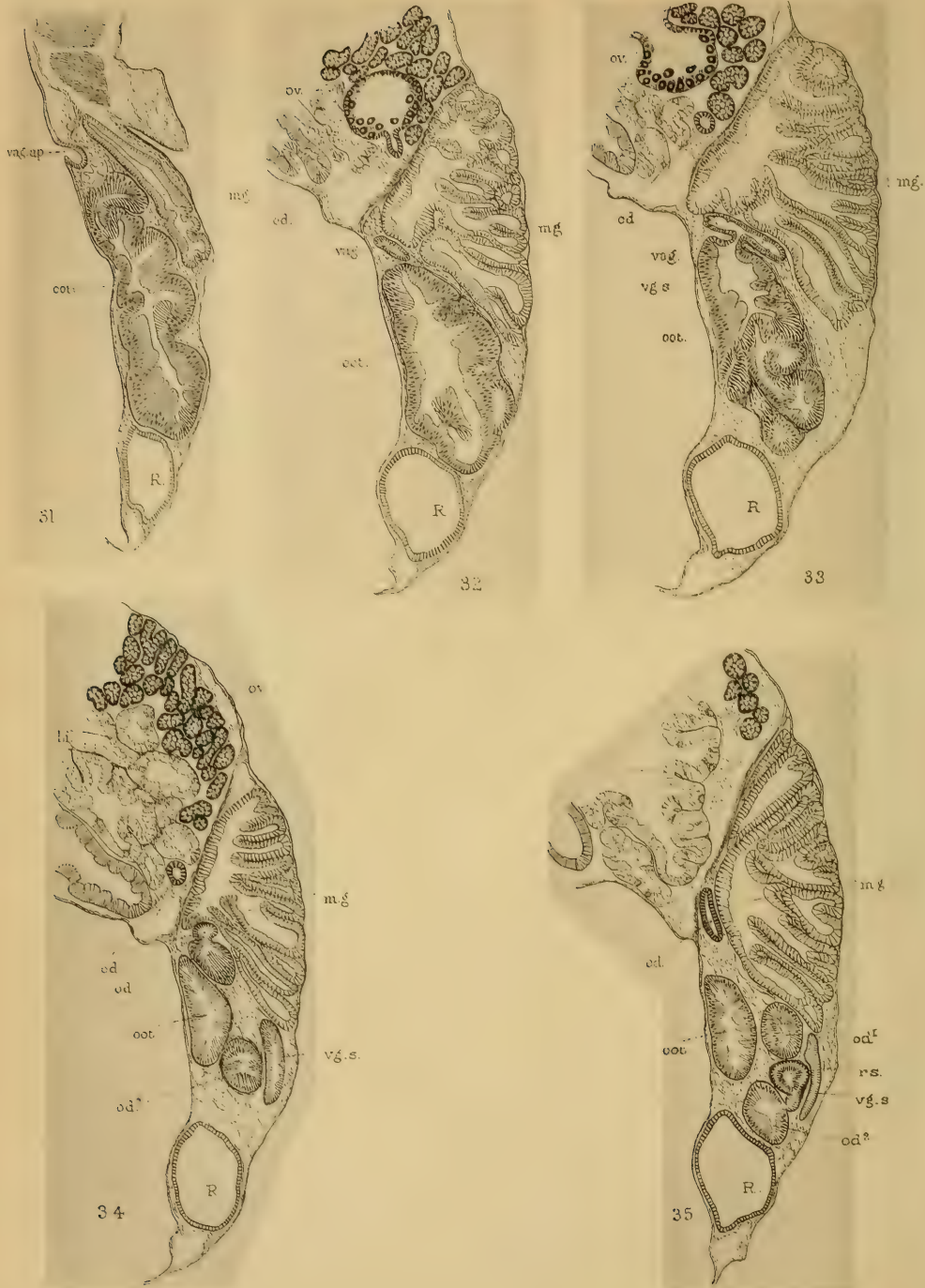
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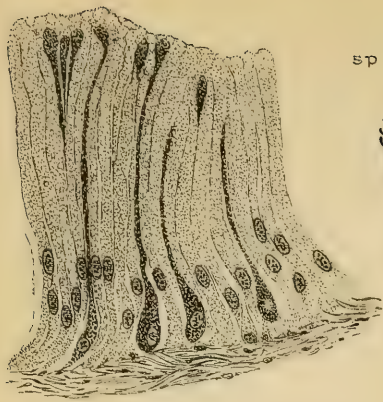




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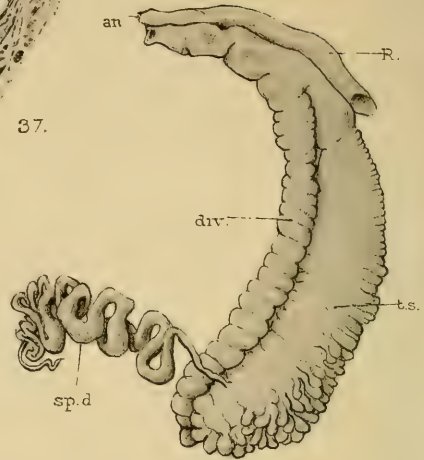




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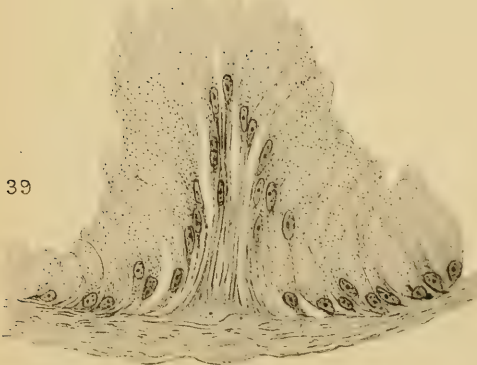
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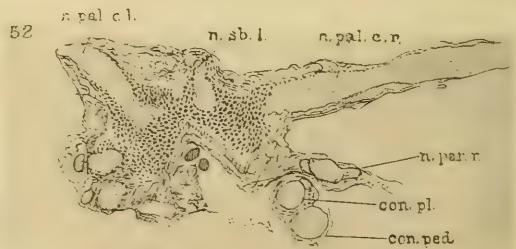
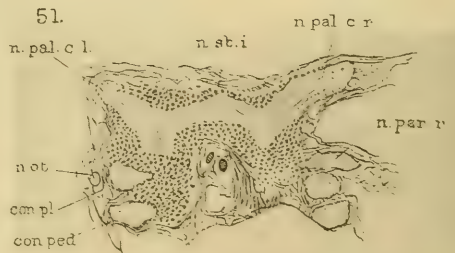
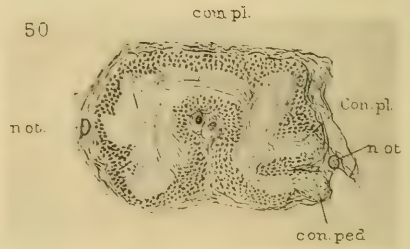
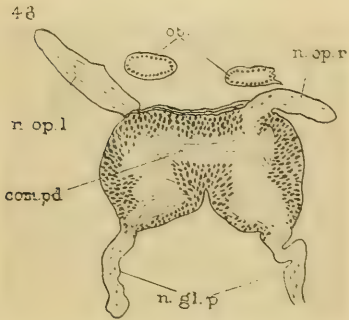
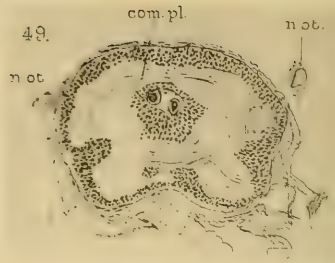
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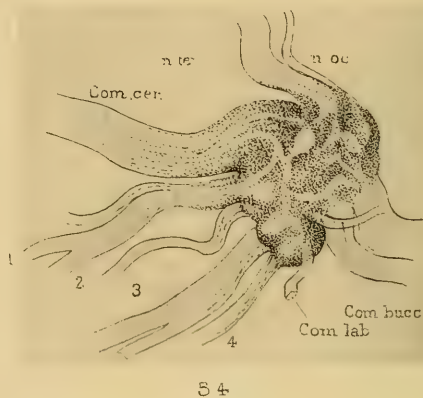
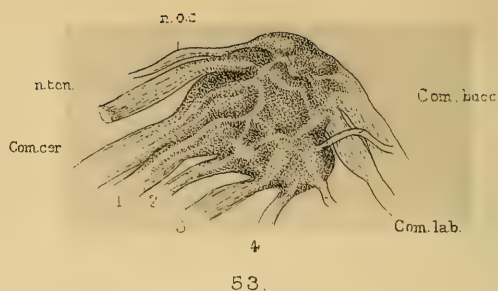
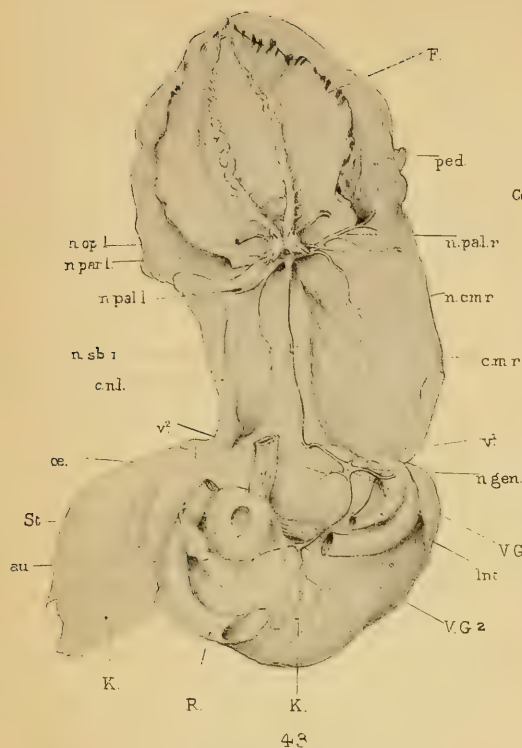


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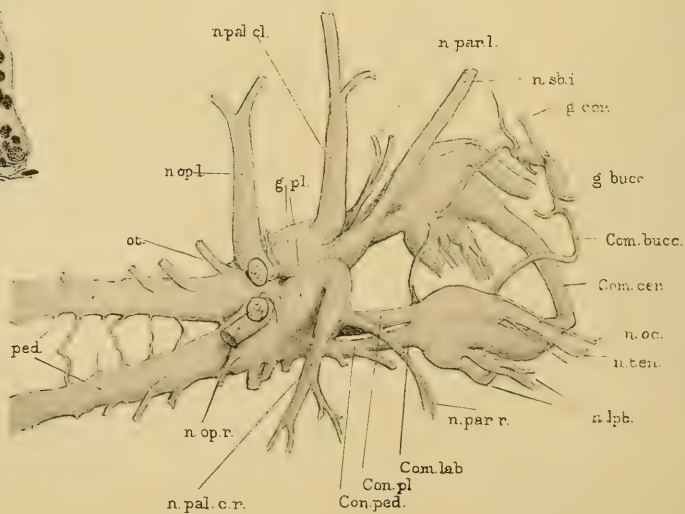
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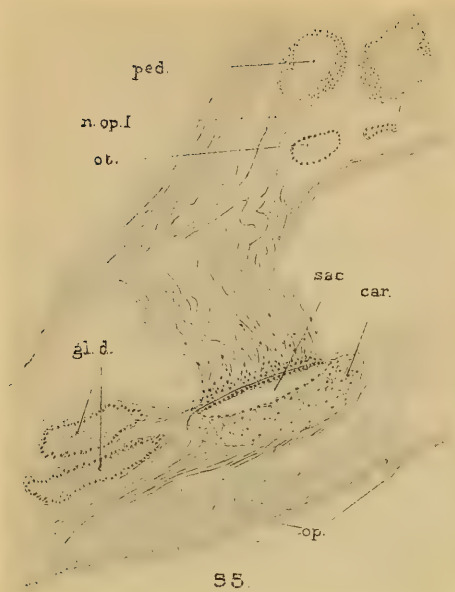




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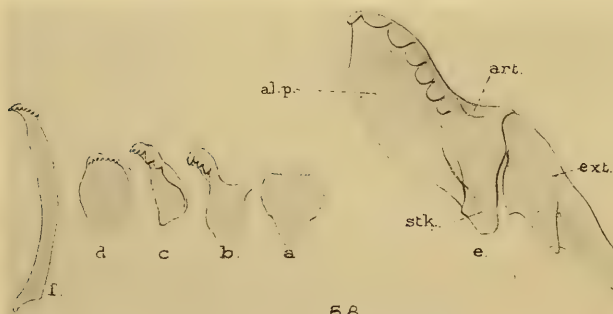




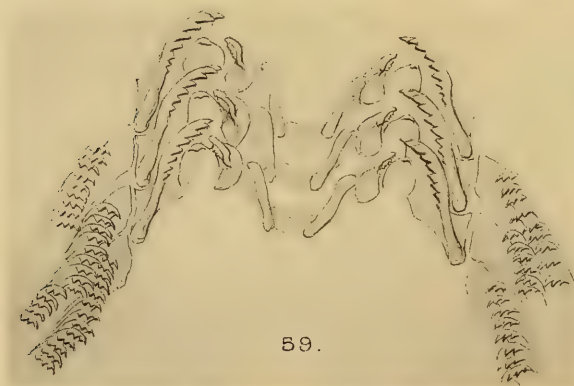
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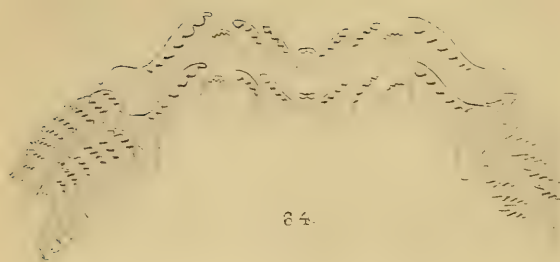
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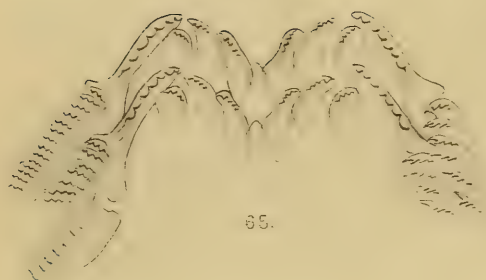
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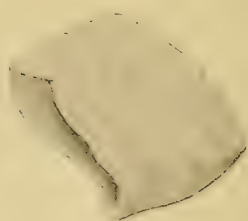
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patches by digging holes to lay their eggs; so they asked the Shark to take the Megapodes away. This was done, but now the natives missed the Megapodes' eggs, so they asked the Shark to bring the Megapodes back but to confine them to one spot. This request was also complied with, and the result may now be seen. The Megapodes lay their eggs in two large and broad sandy spaces, and nowhere else on the island.

I suspect that there is more than a grain of true history in this legend, and that it records the fact that when the ancestors of the natives came to the island, they brought with them two main staples of their food-supply — yams and Megapodes.

35. Contributions to the Morphology of the Group Neritacea of the Aspidobranch Gastropods.—Part II. The HELICINIDÆ. By GILBERT C. BOURNE, M.A., D.Sc., F.R.S., F.Z.S.

[Received April 29, 1911: Read May 9, 1911.]

(Plates XXX.—XLII.*)

When, two years ago, the Society published the first part of my contributions to the morphology of the Neritacea (2), I had already accumulated a number of observations on the anatomy of the Helicinidæ, but deferred the publication of them until I was able to obtain specimens of different species from various parts of the Pacific region. Having experienced considerable difficulty in obtaining specimens sufficiently well preserved for microscopical examination, the publication of my results has been long delayed, with the result that I lose the claim to priority for several minor discoveries concerning the anatomical features of this family, for, in the meantime, Thiele (10) has given an account of the anatomy of *Hydrocena cataroensis* in which is included a description of the female generative organs of *Helicina kubaryi*, and the following descriptions lose much of the novelty they would have possessed had they been published as soon as the facts were ascertained.

Previous to the publication of Thiele's paper, our knowledge of the anatomy of the Helicinidæ rested, for the most part, on Isenkrahe's (4) account of the anatomy of *Helicina titanica*. Isenkrahe gave a sufficiently accurate description of the external anatomy, the muscular system, the greater part of the alimentary tract, and the pulmonary cavity, but he failed altogether to distinguish the kidney, and his descriptions of the heart, the nervous system, and the reproductive organs are defective. These imperfections notwithstanding, Isenkrahe was able to confirm Troschel's opinion that *Helicina*, on account of its rhipidoglossate dentition and other anatomical characters, was closely related to the Neritidæ.

Von Jhering (5) in 1877 placed the Helicinacea and Proserpinacea

* For explanation of the Plates see pp. 806-809.

in his class Orthoneura, order Rostrifera, sub-order Rhipidoglossa, and gave a fairly accurate description, unaccompanied by a figure, of the nervous system of *Helicina* (*Sturanya* Wagner) *beryllina* Gld. E. L. Bouvier (3), in his great work on the nervous system of Prosobranch Gastropods, gave a very complete account of the nervous system of *H. sagraiana* d'Orb. and *H. brasiliensis* Gray, laying stress on its close resemblance to the nervous system of the Neritidæ, and in addition he made some further observations on the general anatomy, partly confirming and partly correcting and adding to Isenkrahe's descriptions. In 1902 Thiele (9) described the male generative organs of *Helicina japonica*, and last year he gave a description with a diagram of the female organs of *H. kubaryi*, in addition to a succinct but sufficiently exhaustive account of the general anatomy of *Hydrocena cattaroensis*.

The geographical distribution of the Helicinidæ, as is well known, presents several interesting and difficult problems. By far the greater number of species are insular and confined to the tropics. Such species as are found on continents are for the most part limited to regions near the coast, very few being known to occur any considerable distance inland. No Helicinidæ are recorded from Africa. In Europe the group is represented only by the genus *Hydrocena* from the Dalmatian coast, and this genus, as Thiele's recent work has shown, differs in several important anatomical characters from *Helicina* and its more closely allied genera. *Georissa*, a subgenus of *Proserpina*, is the only representative of the group in India, and no Helicinidæ have as yet been recorded from Ceylon. The number of genera and species reaches its maximum in the Antilles. The genus *Helicina*, as restricted by Wagner, is fairly abundant in Mexico and the Central American republics, and extends northwards into Texas and Florida, southwards into Ecuador and Peru on the west coast and to the south of Brazil on the east coast of S. America. Few species, however, are recorded from the Pacific coast of S. America, but, notwithstanding their comparative rarity on these shores, the group reappears in great abundance in the Pacific islands, extending as far east as the Marquesas and Paumotu Islands, and having many representatives in the Society, Samoan, Friendly and Fiji Islands, and in the New Hebrides and New Caledonia. Several species occur on the east coast of Australia, and some few are recorded from New Guinea, Celebes, Borneo, and Sumatra; none, so far as I can ascertain, from Java. But in this part of the world the Helicinidæ attain their maximum in the Philippine Islands, which are only second to the Antilles in the number of species. From thence the group extends north, beyond the tropical zone, to the Bonin Islands and Japan. A few species are found beyond the south-east coast of China and Siam, others again in the Malay Peninsula and Burma. Several species are found in the Andaman and Nicobar Islands, but the group is very poorly represented in the Indian Ocean. *Aphanoconia* (*Helicina*) *theobaldiana* G. & H. Nevill is recorded from the

Seychelles, and *Pseudotrochatella undulata* Morelet is a subfossil form from Mauritius. None is known from Madagascar.

In a recent work of great value to the student of geographical distribution A. J. Wagner (12) has revised the family Helicinidæ, and, founding his diagnoses chiefly on the characters of the operculum, has broken up the old genus *Helicina* into no less than thirteen genera, reserving Lamarek's appellation for the American and Antillean forms which conform to the original definition of the genus. Of the remainder I mention the largest genera. *Sulfurina* has its centre in the Philippines and extends thence to the Andamans, Nicobars, Moluccas, New Guinea, and Tahiti. *Aphanoconia*, which also seems to be centred in the Philippines, extends widely, to Japan, S. China, the Malay Archipelago, the Andamans, Nicobars, Seychelles, Moluccas, and through Micronesia and Melanesia to the Paumotu and Sandwich Islands. *Sturanya* has its centre in Fiji and Tonga, and extends thence to the Carolines, Sandwich, Society, Hervey, and Solomon Islands. *Orobophana* is found in Queensland and N.S. Wales and extends through nearly the whole of Polynesia. *Palæohelicina*, with its subgenus *Ceratopoma*, is again a Philippine genus, and extends to New Guinea, the Bismarck Archipelago, the Solomon, Louisiade and Pelew Islands. The last-named genus is, according to Wagner, closely allied to *Helicina* sensu restricto. Again, the subgenus *Retorquata* of *Helicina*, which occurs in Mexico and Central America with outliers in Florida and Texas, affords, according to the same author, a transition to such a characteristic Antillean genus as *Alcadia*. A consideration of these statements leads to the conclusion that the Helicinidæ are capable, by what means we know not, of wide dispersal across seas and oceans, and find conditions most suitable to their existence in proximity to the sea. They appear to have originated in Mexico and Central America, and to have spread eastwards to the Antilles, where they found the conditions specially suitable, and have been differentiated into several genera (*Alcadia*, *Lucidella*, *Eutrochatella*, *Priotrochatella*, *Proserpina*) and numerous species, and one species (*H. substriata convexa* Pf.) has found its way to the Bermudas. Others have extended down the eastern coast of S. America, but the Atlantic Ocean has proved an impassable barrier to their further extension eastward. On the Pacific side the group has been transported by some means unknown to us to the Pacific Islands, and it would appear from the evidence that it did not at first effect a lodgment in the more eastern islands, but in the Philippines, from which centre it has spread in all directions—eastward throughout Polynesia and to the Sandwich Islands, southward to New Guinea and Australia, northward to Japan and China, westward through the Dutch Indies and Malaya to the Andaman and Nicobar Islands. Very few have traversed the Indian Ocean to reach the Seychelles and Mauritius.

Very little is known of the geological history of the group. *Helicina* occurs in the post-Pliocene of N. America, but the

ancestral forms must have lived at a much earlier period, for *Proserpina* is recorded from the Eocene of the Isle of Wight, and, according to Kobelt (6), shells referable to the same genus have been found along with *Helix*, *Planorbis*, *Valvata*, and three species of *Neritina* in the Lias of Somerset. There is some reason for suspecting the correctness of the identifications in the last case, and I am unable to find any corroborative evidence of the occurrence of *Proserpina* in the Eocene, but the distribution of the Hydrocenidæ points to a geological history reaching well back into Tertiary times. *Dawsoniella* from the Carboniferous of Illinois has been attributed to the Helicinidæ, but I have already, in the first section of this memoir, discussed the affinities of this genus and pointed out that it must be a case of convergence.

However this may be, palæontology throws very little light on the origin and distribution of existing Helicinidæ, and when I began this work I hoped, not only to give a full description of the anatomy of a typical member of the family, but also, by the comparison of the anatomy of Pacific and West Indian forms, to discover some clue to the distribution of the group with its two main centres in the Antilles and the Philippines. In this, as will appear, I have been disappointed. From whatever part of the world they may come, the anatomy of the different species and even genera of Helicinidæ is so closely similar that it is hard to find any difference between them. It is true that I have not been able to procure many species of Pacific Helicinidæ, but I have examined fairly well preserved specimens of *Orobophana*, *Aphanoconia*, and *Paleohelicina*, and these three genera may be taken as typical of the more widely distributed Pacific forms.

The material at my disposal was as follows:—

I. Antillean forms.

- Alcadia palliata* Ads. Contrivence, Walderston, Jamaica.
Alcadia hollandi Ads. Swing Hill, Walderston, Jamaica.
Lucidella aureola Fér. Bog Walk, Spanish Town, Jamaica.
Eutrochatella pulchella Gray. Bog Walk, Spanish Town,
 Jamaica.

The above were kindly collected for me and preserved in Perenyi's fluid by Mrs. G. B. Longstaff, F.L.S.

II. Pacific, Australian, and Indian forms.

- Aphanoconia gouldiana* Forbes, from Torres Straits: for specimens of this species I am again indebted to Mrs. Longstaff, who procured them for me from Mr. C. Hedley, of the N.S. Wales Museum.
Aphanoconia andamanica Benson.
Aphanoconia merguiensis Pfeiffer.
Aphanoconia rogersii, sp. n.

These three species are from the British Museum and formed part of the collection made in the Andaman Islands by Mr. G. Rogers.

They were numbered respectively 16, 30, and 31. The first two I have identified without difficulty, the third appears to be new to science, and I will give a diagnosis of it in the latter part of this paper. I am indebted to Mr. E. A. Smith for these and for the two following species:—

Orobophana pachystoma ponsonbyi Smith. Admiralty Islands.
Palæohelicina idæ Wagn. Amboina.

In describing the anatomy it will be convenient to take *Alcadia* as the type, and to note such differences as may exist between it and the other genera at the end of the description of each system of organs.

*External Characters, Mantle, Mantle-cavity,
 and Muscular System.*

Isenkrahe (4) has given an account of these so sufficient and accurate that it is not necessary for me to do more than call attention to some special features exhibited in fig. 1 (Pl. XXX.), which is a representation of a left side view of *Alcadia palliata*: the mantle has been cut through on the left side close above the columellar muscle, the cut has been extended back to nearly the extreme hinder end of the mantle-cavity, and the mantle has been turned over towards the right. As compared with the Neritidæ, in this and in all the other species of Helicinidæ that I have examined the foot is attached to the head and body by a longer and narrower pedicle, the opercular lobe is relatively smaller, the snout is narrower and longer, the columellar muscles of greater antero-posterior length, and the whole body is longer, giving the appearance of an increase in the coiling of the visceral mass, but this last feature is more apparent than real, as I shall show. A glance at the figure shows that the increased length of the body is chiefly due to the elongation of the post-tentacular region and the part of the body immediately following. Using Amaudrut's (1) phrases, we have an almost extreme case of "allongement posttentaculaire," followed by an "allongement dorsal," and many of the peculiar features of helicinid anatomy are to be explained by the excessive growth in length of these two regions. The post-tentacular region lies above the anterior two-thirds of the columellar muscle, and its posterior limit is marked by two or three deep wrinkles of the body-wall. The body-wall of this post-tentacular region is fairly stout and muscular, and the epidermis is, as a rule, deeply pigmented. The colour differs in different species. It is nearly black in *Alcadia*, grey shading posteriorly into white in *Eutrochatella pulchella*, yellowish grey in *Lucidella aureola*, a dark chocolate-brown in *Palæohelicina idæ*, and a bright chestnut-brown in *Aphanoconia gouldiana*. In the post-tentacular region are contained the buccal bulb and the greater part of the œsophageal pouches. In the dorsal region following on the post-tentacular the body-wall is thin and nearly

transparent, the musculature is feeble, and the epidermis is not pigmented. This dorsal region is relatively of considerable length; its concave lower border corresponds very closely in length with the surface of insertion of the left columellar muscle; its upper surface extends back to the pericardium. It contains nearly all the coils of the intestine, the œsophagus, the radular sac, and the hinder lobes of the œsophageal pouches. Its roof forms the floor of the hinder part of the mantle-cavity. In consequence of the elongation of these two regions, but particularly of the dorsal region, the mantle-cavity is continued very far back; so far that, measured from its most anterior to its most posterior limit, it makes nearly a complete turn of a spiral, whereas in *Nerita* and *Neritina* it makes little more than half a turn. Broad in front where its roof passes from the right to the left columellar muscle, the mantle-cavity becomes narrower and narrower posteriorly and ends in a pointed *cul-de-sac* below and somewhat to the right of the lower surface of the visceral mass. Its extreme posterior limit is not quite visible in fig. 1. With the hinder end of the mantle-cavity the pericardium has also been carried very far back. It is laid open in fig. 1 to show the position of the heart. It will be seen that the single auricle seems to lie behind the ventricle, and not in front of it as does the larger left auricle in the *Neritidæ*. In horizontal sections, such as those depicted on Pl. XXXIII. figs. 18 and 19, this posterior position of the auricle forces itself so much upon one's attention that I was led to form the theory that the single auricle of the *Helicinidæ* corresponds not to the left and larger, but to the right and rudimentary auricle of the *Neritidæ*; and in my memoir on the morphology of the latter family (2, p. 833) I prematurely gave expression to this view, which seemed to me the more probable because I found that in correlation with an increase of the pallial vessels in *Septaria* the right auricle became relatively larger and took an obviously larger share in carrying blood from the pallial vessels to the ventricle. But since then, after a careful study of the relative positions of the kidney, the uropore, the rectum, and the heart in the *Helicinidæ*, I have satisfied myself that this view was erroneous.

As a consequence of the dorsal elongation of the body all these organs have been rotated through an angle of rather more than 90° , in such wise that the pyloric end of the stomach, which in the *Neritidæ* is directed forward and to the left, comes to lie at the right posterior end of the body in the *Helicinidæ*, and the swollen œsophageal end of the stomach, which is posterior and somewhat to the left in the *Neritidæ*, is directed anteriorly and to the right in the *Helicinidæ*, forming a conspicuous rounded prominence at the extreme end of the visceral mass (Pl. XXX. fig. 1, *St.*). To understand the nature of this rotatory movement the reader should refer to fig. 42 of my memoir on the *Neritidæ*. This figure represents a horizontal section of *Paranerita gages*, and shows the position of the œsophageal (*St.*) and pyloric (*St.*) divisions of the stomach. It should be noticed

that the extremity of the visceral mass, lying to the right, is wholly occupied by the liver and gonads. If, now, the reader will lay a tobacco-pipe in front of him on the table, the bowl (representing the œsophageal division of the stomach) to his right, the stem (representing the pyloric division of the stomach) to his left front, it will occupy much the same position as does the stomach in the figure referred to. If, while the bowl is kept pressed against the same spot on the table, the stem is lifted up and rotated through an angle of rather more than 90° till it points over the observer's right shoulder, the whole pipe will have been rotated through an angle which brings it into the position of the stomach of the Helicinidæ—the animal being supposed to be placed foot downwards upon the table with its head turned away from the observer. As all the organs of the left side of the body, including the posterior end of the mantle-cavity, the pericardium, the heart, the kidney, and the coils of the intestine, have shared in this movement of the pyloric end of the stomach, their positions have been nearly completely reversed, and the left auricle instead of lying in front of the ventricle has come to lie behind. The right auricle has entirely disappeared in the Helicinidæ, and the rectum, having undergone some degree of displacement in connection with the above-described movement of rotation, is no longer enveloped by the ventricle.

The kidney has also undergone a curious and at first sight a puzzling change of position. In the Neritidæ, as described in my previous memoir (2, see Pl. XLVI. fig. 1 for its position in *Septaria*, Pl. LIV. fig. 29 for its position in *Paranerita gagates*), its glandular part lies to the left hand of and partly below the rectum: posteriorly the glandular part opens into the spacious non-glandular bladder or ureter, and the latter runs forward, below the glandular part, to open by the uropore into the mantle-cavity on the right of and close to the base of the ctenidium. In this family the greater part of the kidney lies in the roof of the mantle; it is only its posterior extremity that passes below the rectum and invades the visceral mass, where it lies just above the pyloric end of the stomach. The effect of the rotation of the last-named organ in the Helicinidæ is that the kidney has been carried round till it comes to lie wholly in the visceral mass, on the lower side of the latter, between the loop of the rectum which passes round this region and the pyloric division of the stomach, as may be seen in the series of sections (Pl. XXXIII. figs. 17 to 20) and in the diagram (Pl. XXXIV. fig. 24), which is a reconstruction from this series of sections. The kidney, in short, has been turned completely round, so that its originally posterior end looks to the left front and the uropore opens into the right hinder corner of the mantle-cavity, the reno-pericardial canal, maintaining its relation to the uropore, into the right posterior corner of the pericardium. It is further to be observed that the visceral mass, though apparently more coiled, is really less coiled in the Helicinidæ than in the Neritidæ. In all systematic works stress

is laid on the fact that the internal partitions of the shell are absorbed in both these families. This absorption has not proceeded quite so far in the Neritidæ as in the Helicinidæ. In *Nerita* and *Paranerita* there is a recess in the upper right-hand part of the shell which contains that lobe of the visceral mass which consists wholly of liver and gonads and represents the visceral spire of other Gastropods. This recess and the lobe of the visceral sac corresponding to it are not found in the Helicinidæ: the wall of the œsophageal division of the stomach comes very near to the surface (Pl. XXXIII. figs. 17 & 18), and the liver and gonads are disposed at the sides of and above the pyloric division of the stomach. The more coiled appearance of the whole is due to the elongation of the post-tentacular and dorsal regions, not to the retention of a larger section of the visceral spire of the presumed gastropod ancestor than in the Neritidæ.

From what precedes, it follows that most of the peculiarities of the Helicinid organization are the result of excessive growth and elongation of a particular region of the body, and it is an interesting confirmation of the correctness of the above account of the manner in which the Helicinid organization has been derived from the Neritid that, if one makes a plasticine model of the stomach, kidney, rectum, and intestinal coils as they occur in *Paranerita*, and then rotates the stomach in the manner described, the intestinal coils assume very nearly the position found, with more or less variation in detail, in all Helicinids.

After this general explanation of the mutual relations of the principal visceral organs in the Helicinidæ, I need only refer to particular features in the several systems of organs which I have to describe in detail. Before proceeding, it should be put on record that there is not a rudiment of the ctenidium in the Helicinidæ, and I cannot even find a trace of an osphradium. The cephalic penis, characteristic of the males of the Neritidæ, is also absent, and there is no external difference between the males and females in any of the species that I have examined.

The Alimentary Tract.

The complex of organs formed by the buccal cavity, the pharynx, the œsophagus with its smaller and larger glandular annexes, the radula, the radular sac, and the odontophoral cartilages and their muscles, can only be studied by dissection, and this is by no means an easy task in animals so small as most species of Helicinidæ are. The relations of the various organs to one another are far too complicated to trace out in sections. The following description applies chiefly to *Alcadia palliata* and *A. hollandi*, but will serve almost equally well for any of the other species that I examined, for all are very much alike except for the details of the radular teeth.

The mouth is a gaping circular orifice, situated at the extremity of the downturned snout: it is surrounded by folded muscular lips.

The buccal cavity occupies the snout, in front of the tentacles. It is a simple funnel-shaped cavity bounded by a rather thick muscular wall, the internal surface of which is thrown into about 19 or 20 longitudinal folds. The cavity is lined by a layer of rather long columnar epithelial cells which secrete a thick cuticle. Dorsally the buccal cavity is prolonged backward into a little glandular diverticulum which lies above the median part of the cerebral commissure. The buccal cavity is separated from the pharynx by a constriction, deepest on the dorsal side, where the cerebral commissure lies in it. In a surface view, before disturbance of the various parts, this constriction is not visible from above, as it is covered over by the anterior salivary glands shortly to be described, and muscle-fibres pass from the walls of these glands to the walls of the buccal cavity and of the snout. Consequently the cerebral commissure seems to be embedded in the buccal mass.

The passage from the buccal cavity to the pharynx is narrow. The pharynx is a relatively spacious sac, of which the cavity is continued posteriorly into the œsophagus above and into the radular sac below. Beneath and at the sides of the anterior end of the radular sac lie the odontophoral cartilages, the anterior ends of which project forward into and occupy the greater part of the lower moiety of the pharyngeal cavity. It will readily be understood that, in consequence of the projection of the anterior ends of the odontophoral cartilages into the pharyngeal cavity, the latter extends round them both at the sides and below. Below the cartilages the pharyngeal extension forms a broad flattened diverticulum, reaching back nearly to the posterior ends of the anterior cartilages, as far as the point marked *x* in fig. 3 (Pl. XXX.). Laterally, the line of attachment of the pharyngeal wall to the anterior odontophoral cartilages is roughly indicated in the same figure by the curved line running upward and forward from the point *x* towards the opening of the œsophagus. It results from this arrangement that in an oblique section, such as is represented in fig. 4 (Pl. XXX.), the pharynx appears to give off two posterior diverticula, lying outside the anterior ends of the odontophoral cartilages. The inner walls of these diverticula are thin and composed of a single layer of cubical epithelial cells: they are continued round the anterior and upper edges of the cartilages into the lining membrane of the radular sac. The outer wall of each diverticulum is strengthened by a thin plate of cartilage, too small and transparent to be recognized in dissection, but readily recognizable in sections. These lateral pharyngeal cartilages serve for the attachment of muscles, one set of which run forward to be inserted on the walls of the snout, the other set run backward and are inserted on the odontophoral cartilages; the former are protractors, the latter retractors, of the walls of the pharynx.

A portion of the epithelial lining of the outer wall of each

diverticulum is composed of very long attenuated epithelial cells, among which are long club-shaped glandular cells. This glandular strip may be traced upward and forward to the thickened lip of the œsophageal opening, where it forms a prominent ridge which passes above into the anterior pair of salivary glands, to be described shortly.

As is shown in Pl. XXX. fig. 2 and in the section drawn in fig. 4, the radular sac opens into the pharynx by a widely gaping aperture situated in the trough-shaped depression between the anterior ends of the anterior odontophoral cartilages. Posteriorly the radular sac passes between the posterior odontophoral cartilages and runs at first to the right of and below the œsophagus, but soon mounts upwards and to the left, the two organs, œsophagus and radular sac, being twisted round one another as shown in fig. 2. The radular sac is short in *Alcadia palliata* and is of no great length in any of the species that I have studied. The greater or less length of the radular sac appears to be an individual rather than a specific character. The characters of the radular teeth will be dealt with in a separate section.

The odontophoral cartilages were described in some detail by Isenkrahe for *Helicina titanica*, and I have but little to add to his account. A ventral view of these structures in *Alcadia palliata* is given in Pl. XXXI. fig. 5, and a sketch of a dorsal view of the same structures in *Eutrochatella pulchella* in fig. 6: both figures are drawn to the same scale. As may be seen from the specimens figured, the odontophoral cartilages exhibit specific differences in relative size and proportion, but these differences are of too slight and elusive a character to be expressed in a description, and scarcely important enough to make it worth while to give a separate figure for each species examined. The essential structure is the same in all. There are two pairs of cartilages, an anterior and a posterior. Each member of the anterior pair is a plate having the form of a more or less elongated isosceles triangle; the margins of the plate are thickened and rounded, the central portion remains thin. The plate is bent in such a way that its lower margin is bent inward posteriorly and its upper margin outward. The posterior margin or base of the triangle, forming the articular surface for the posterior cartilage, runs obliquely from above downwards and inwards. The lower margins of the two cartilages are connected by a tough fibrous band, and their thickened edges serve for the attachment of the intrinsic and extrinsic odontophoral muscles. The posterior cartilages are short conical masses; their apices directed backwards; their ventral surfaces convex and their dorsal surfaces more or less concave. Their broad anterior ends are shaped to correspond with the articular surfaces of the anterior cartilages, and the two are firmly held together by muscular fibres, whose arrangement is indicated in fig. 5. It follows from the above description that the odontophoral cartilages form the sloping sides of a V-shaped trough, the concavity of which looks upwards and supports the

anterior part of the broad radular ribbon. The median and admedian radular teeth lie in the floor of this trough, the great lateral teeth lie in the angles between its floor and sides, and the uncini form curved rows running upwards and backwards along its sloping sides. The radular ribbon is attached by strong muscular bands to the cartilages. These muscles run obliquely forwards from the radula to be attached to the anterior cartilage of either side, and obliquely backwards to be attached to the posterior cartilages, these two sets of muscles causing the ribbon to slide forward and backward over the smooth surfaces of the cartilages.

The relation of the œsophagus to the radular sac and odontophore is shown in fig. 3, which is a drawing of a dissection of these structures in *Alcadia palliata*. The left œsophageal pouch and the left side of the œsophagus have been cut away, and the roof of the œsophagus has been lifted back to the right side to show the entrance to the right œsophageal pouch and other structures. In the angle of the deep fold between the œsophagus and radular sac are seen the buccal ganglia (*g.buc.*) lying just above the middle of the anterior odontophoral cartilages. The opening of the œsophagus into the pharynx, situated just in front of and above the buccal ganglia, is irregularly funnel-shaped, with thickened and folded lips projecting forward into the pharyngeal cavity. Laterally, these lips are deeply grooved, and on either side the groove is continued backward and downward into the lateral pharyngeal diverticulum described above, and upward and somewhat forward into the anterior salivary gland of its own side. These anterior salivary glands are formed by a pair of pocket-like forward projections of the œsophagus, which in their natural position lie side by side and form a pair of pouches lying above the cerebral commissure. Between them is an anterior cæcal diverticulum continuous behind with the median dorsal groove of the anterior part of the œsophagus. When separated by an incision in the mid-dorsal line and turned outwards, the anterior salivary glands present the appearance shown in fig. 2. Internally their walls are raised into a number of thick glandular ridges: the outermost of these ridges is specially thick and is continued downward, in the groove passing to the side of the œsophageal orifice, into the glandular ridge on the outer wall of the pharyngeal diverticulum, as has been described above.

The anterior section of the œsophagus, lying above the odontophore, is fairly wide. Internally, its walls present a number of longitudinal glandular ridges, and in the mid-dorsal line there is a deep groove bounded internally by prominent ridges; posteriorly this groove shallows and eventually dies out. On either side of this anterior section of the œsophagus is a gaping oval orifice (figs. 2 & 3, *o.e.p.*) leading into the large œsophageal pouches, or, as some would call them, the posterior salivary glands. The last-named structures are capacious irregularly lobulated sacs with large cavities. Their inner walls are

lined throughout by a glandular epithelium, consisting, as far as I was able to determine, almost wholly of very long goblet-shaped secretory cells containing zymogen granules, with very few attenuated supporting cells lying between. The histological characters of the epithelium were not, however, very well preserved in any of my specimens. The two pouches are closely pressed against the sides of the œsophagus, and in the species in which they are longest follow the turns of the latter. Hence, as the œsophagus makes a turn towards the left before it passes down through the loop of the rectum, the right œsophageal pouch generally passes over to the left side and above the œsophagus, the left pouch passing to the right and below the œsophagus and radular sac. The œsophageal pouches are relatively short in *Alcadia palliata* and of approximately equal width throughout, but they are much longer and diminish in diameter towards their posterior extremities in *A. hollandi*. They are particularly long and of a deep chocolate colour in *Palæohelicina idæ*; in most species they are white in spirit-specimens.

Behind the openings of the œsophageal pouches the œsophagus narrows somewhat abruptly in diameter; the glandular internal longitudinal ridges disappear, and are replaced by nine or ten longitudinal ridges formed by columnar ciliated epithelial cells, and these may be traced throughout its course to the stomach. This course is a long one, for the stomach lies aslant on the lower side of the visceral mass, below the greater part of the lobes of the liver and below the coils of the intestine. As seen from above and behind, it is a large pyriform sac, the narrower end lying just above the posterior corner of the pericardium; the broader end forming on the right side of the visceral mass a large rounded prominence which fits into the concavity on the ventral side of the right columellar muscle. The œsophagus enters the stomach on the upper side of its broader end, and its course in the several species examined will be best understood by reference to Pl. XXXII. figs. 10 to 15. Passing to the left as it enters the visceral mass, the œsophagus lies above the first coils of the rectum, then passes below the recurrent coil of the rectum, and so arriving at the dorsal surface of the stomach runs along the latter as a flattened tube and opens, as stated above, into its broader end, dilating considerably just at its point of entrance. This dilatation, which might almost be described as a diverticulum of the stomach itself, receives right and left the wide ducts of the liver (Pl. XXXI. fig. 7, and Pl. XXXII. fig. 16, *h.d.*).

The internal structure of the stomach is very complicated. It attracted the attention of Isenkrahe, who gave a fairly accurate description of it. Fig. 7 is a representation of a dissection of the stomach made from behind and below the visceral mass. The œsophagus is shown at *æ.*, and its entrance into the stomach is indicated by the arrow. The entrance of the left liver-duct is shown at *h.d.*; that of the right liver-duct lies on the far side of the prominent curved ridge guarding the entrance to the

œsophagus. Both the œsophageal aperture and those of the liver-ducts are surrounded by complicated epithelial ridges, which, as shown in the drawing, converge towards and pass into a deep groove running along the dorsal side of the narrower pyloric moiety of the stomach. The edges of this groove are bounded by two prominent folds; that on the right side (the left in the drawing) being continued towards the œsophageal opening as a projecting ridge, ending at the side of the aperture in a very prominent crescentic projection covered by a thick iridescent cuticle.

The internal surface of the stomach is lined by a mixed glandular and ciliated columnar epithelium, the characters of which are shown in Pl. XXXI. fig. 8; the glandular elements predominate in the œsophageal, the ciliated elements in the pyloric moiety of the stomach. The epithelial cells are lower in the furrows, taller and more slender in the ridges, these latter structures being formed entirely by thickenings of the epithelium, and not by foldings of the wall of the stomach. The crescentic projection to the right of the œsophageal opening is formed by a local modification of the epithelium, the cells of which are here extraordinarily long, with nuclei placed about the middle of their length, and with apparently homogeneous transparent cytoplasmic contents (Pl. XXXI. fig. 9); they are all of one kind, without any admixture of glandular cells, and, so far as one can judge, they are not themselves glandular. The free ends of these cells are covered by a very thick and tough cuticular coat, which stains deeply in hæmatoxylin, brazilin, and other ordinary dyes. The whole structure corresponds to the "flèche tricuspidé," of which the characters have been thoroughly described for Lamellibranch stomachs, and which has been noted as occurring in several Gastropod stomachs. There is no definite crystalline style in Helicinidæ, but in several specimens that I dissected I found the cavity of the stomach filled by a semitransparent gelatinous mass, which appeared to be similar in origin and composition to a crystalline style. In several specimens I found that the intestinal end of the groove of the pyloric moiety of the stomach was occupied by closely compacted faecal pellets or rods, while the cavity below was filled either by the gelatinous mass above mentioned or by a loose mass of semi-digested food. It may be inferred from this that digestion is effected in the general cavity of the stomach, and that the indigestible materials of the food are collected into the dorsal groove and passed into the intestine.

Morphologically, the stomach of the Helicinidæ closely resembles that of the Neritidæ, and further bears a resemblance to the stomachs of the Fissurellidæ and Scissurellidæ, which, as in this case, have a groove leading from the hepatic ducts towards the intestinal end of the stomach, but no spiral cæcum.

The small intestine is a comparatively narrow tube, which after leaving the pyloric end of the stomach runs back for a short distance over the dorsal surface of the latter, parallel with the

œsophagus, and then turning upwards and forwards describes one or more convolutions before it passes into the large intestine. The small intestine can always be distinguished by its white colour and narrow diameter; it varies considerably in length in different species, being longest in *Alcadia palliata* and *Orobophana ponsonbyi*, shortest in *Eutrochatella pulchella*. Internally it is lined by a columnar ciliated epithelium containing a few gland-cells, and its internal surface is increased by a well-marked internal ridge or typhlosole formed by long ciliated cells. The small intestine passes abruptly into the large intestine, the latter being of much larger diameter and having pigmented walls. In all species of *Alcadia* and *Helicina* examined, the large intestine runs forward and to the left below the œsophagus, then bends abruptly back, forms a wide circular loop which passes above the œsophagus, in front of the anterior end of the stomach and along the inner wall of the anterior end of the pericardial cavity: it then turns downwards and to the right, passes right round the lower side of the stomach, and mounting upwards again behind it runs in the right side of the roof of the mantle-cavity to open by the anus, opposite the right tentacle. In the first part of its course, *i. e.* in the short length between the small intestine and the recurrent circular loop, the large intestine is lined by very evenly disposed columnar ciliated cells, among which I could not detect any gland-cells, and this part of the intestine is not, as a rule, full of faecal matter. This section of the intestine may be described as the large intestine proper, to distinguish it from the rectum, into which, however, it passes without any obvious line of demarcation. The rectum is always full of faecal debris, and its epithelium consists of (1) columnar ciliated cells; (2) goblet-shaped gland-cells filled with coarse granules which stain deeply in hæmatoxylin and are therefore probably mucinogenous; (3) smaller gland-cells containing small yellow granules. There is no typhlosole either in the large intestine or the rectum.

Noticing that the coils of the gut differed in the different species, I have been at some pains to work out this character in detail, and figs. 10 to 15 (Pl. XXXII.) show the coils characteristic of six different species. An examination of the figures will give a better idea of the differences than any description. It will be noticed that there are three main types. In *Alcadia palliata*, *A. hollandi*, *Orobophana ponsonbyi*, and *Paleohelicina* the intestinal coils, though differing in detail, are alike in this respect, that the small intestine runs back more or less parallel to the œsophagus over the dorsal surface of the stomach, and the large intestine makes a bend to the right below the œsophagus and then, turning back on itself, makes a second bend to the right above the œsophagus. The second type of arrangement is shown in *Lucidella aureola* (fig. 14). In this species the œsophagus is not pressed against the dorsal surface of the stomach, but runs obliquely down to it; the small intestine passes forward from the pyloric end of the stomach, crosses over

the œsophagus, and curves round it till it nearly touches the pyloric end of the stomach again; here it passes into the large intestine, which turns sharply back, passes round the œsophagus again, and coming to the surface sweeps round to the left in front of the anterior corner of the pericardium to form the descending loop of the rectum. This type is easily derived from the first by the shortening of both the small and the large intestine, in consequence of which the former is hooked round the œsophagus and one of the bends characteristic of the first type is suppressed. The third type, seen in *Eutrochatella pulchella* (fig. 15), differs considerably from the other two. The small intestine is even shorter than in *Lucidella*, and the loop formed by the large intestine and the first section of the rectum lies wholly on the dorsal side of the œsophagus; this condition is clearly due to the gut being much shorter than in the other types, and it appears to be quite a constant feature in *Eutrochatella*. The intestinal coils of *Aphanoconia andamanica* are singularly like those of *Eutrochatella*.

I may appear to be giving an undue amount of attention to characters of no obvious morphological or physiological importance, but it is just because they may be claimed to be of importance in the economy of the species that I have spent a considerable amount of time in working out these details. Each species seems to have a characteristic arrangement of the coils of the intestine, and the arrangement is remarkably constant in individuals of the same species, allowance being made for displacements due to the greater or less state of contraction of the specimens. Closely allied species, such as *Alcadia palliata* and *A. hollandi*, have a very similar arrangement, yet sufficiently different to allow one to recognize them at a glance after obtaining some familiarity with their anatomy. *Lucidella* and *Eutrochatella*, both separated from *Alcadia* and from one another by distinctive characters of shell, operculum, and radula, differ in a nearly corresponding degree in the coils of the intestine. *Orobophana* and *Palæohelicina* are Pacific forms which must have been derived from American *Helicine*, the latter being closely related to *Alcadia*, and they resemble the last named in the coils of the intestine. To this extent it may be claimed that two, three, or more characters vary together in these genera; but *Aphanoconia* presents a difficulty, for this genus is far removed from *Eutrochatella* in shell and radular characters, and is in these respects closely related to *Palæohelicina*, yet its intestine is as nearly as may be that of an *Eutrochatella*. As the two genera cannot possibly stand in close genetic relationship to one another, the similarity in the pattern of the intestinal coils must be due to parallelism, similar causes producing similar deviations from type in the two organisms. It has been shown that the differences in pattern are attributable to differences in the length of the large and small intestines, and this is probably connected with different forms of food. As we are ignorant of

the habits of the various species of Helicinidæ, and do not even know for certain whether each or any species is restricted to a particular kind of food, it would be rash to speculate on this question, but such evidence as I have collected does seem to show that such apparently trivial characters as the coils of the intestine are of some physiological importance, and are therefore subject to the action of natural selection.

The Cœlom.

The cœlom is represented by the pericardial cavity, which, although it is of much smaller extent and less complicated than in the Neritidæ, is nevertheless a cavity of relatively considerable size, as may be seen by an inspection of figs. 17 to 20 (Pl. XXXIII.). As is shown in fig. 1 (Pl. XXX.) it comes close to the surface of the left side of the visceral mass, and extends forwards nearly as far as the posterior end of the left columellar muscle and backwards round the lower side of the visceral mass as far as the end of the mantle-cavity. It is bounded externally by the very thin body-wall, posteriorly by the inner wall of the mantle-cavity, internally by the kidney (figs. 17 to 20). At about the middle of its length it is a cavity of considerable depth, extending some way into the visceral mass below the pyloric division of the stomach. The reno-pericardial canal, which will be described in connection with the kidney, opens into its right posterior wall, at some little distance from its hindmost end (fig. 19); otherwise it is a closed sac containing the auricle and ventricle of the heart, and does not require further description.

The Hæmocœle, Circulatory and Respiratory Systems.

The blood-vascular system, as in all Molluscs, consists partly of large lacunar spaces, which collectively are known as hæmocœle, and partly of vessels with definite walls. The hæmocœlic spaces surround the viscera, and there is a specially large lacunar space below the buccal bulb, in which lie the pleuro-pedal ganglia. In the visceral mass and in the dorsal region of the body the hæmocœle is largely filled up by the peculiar form of connective tissue which I have previously described (2, p. 861) as metabolic tissue. In the Helicinidæ the tissue is of precisely the same nature as in Neritidæ, and it is not necessary to describe it again. It evidently consists in large part of reserve tissue, for it is most abundant in immature specimens in which the gonads and gonaducts are but slightly developed, and is much less abundant in sexually mature specimens. This metabolic tissue is specially concentrated round the larger blood-vessels.

It is not possible to trace the course of the blood-vessels by dissection of spirit-preserved specimens and only the larger vessels can be traced in sections. The following account of the circulation embodies as much information as I have been able to

obtain by reconstruction of sections. The ventricle is continued forward into a short and wide aorta, which immediately after passing through the pericardial wall—which it does at about the level of the hinder end of the left columellar muscle—divides into three principal branches. The one passes to the right towards the stomach, and, entering the visceral mass, divides into a number of branches which are distributed to the stomach, the intestine, the right lobe of the liver, the gonad, and the hypobranchial gland and gonaducts. The left branch runs forward for a short distance and then turns downward into the visceral mass and chiefly supplies the left lobe of the liver. A branch is directed towards the posterior part of the left columellar muscle. The third vessel is an almost direct forward continuation of the aorta and runs up in the dorsal region of the body towards the œsophagus; it passes above this organ and runs over the surface of the radular sac, to which organ it becomes firmly attached at about the level of the hind end of the pharyngeal bulb. Here it passes into a number of lacunar passages, supplying the pharyngeal bulb and the œsophageal pouches, and eventually makes communication with the large blood-space surrounding the nerve-centres of the head. This space in turn communicates freely with the lacunæ surrounding the pedal nerve-chords.

In this labyrinth of blood-channels I have not been able to recognize those by which the blood is collected and brought back from the various organs to the organ of respiration, the mantle. The principal hæmocœlic spaces or blood-sinuses are the following: (1) a pedal sinus, surrounding the pedal nerve-cords; (2) a subœsophageal sinus, underlying the buccal mass and œsophagus; this is continued back into (3) a circum-intestinal sinus, in which lie the coils of the intestine and the posterior part of the radular sac; (4) a peri-gastric sinus surrounding the stomach; (5) a recto-genital sinus, running the whole length of the rectum and gonaduct. The last named is evidently the pulmonary vein of Isenkrahe ("längs des Darmes zieht sich die Lungenvene hin"), but it does not carry back blood from the mantle to the auricle. On the contrary, it is easy to see that blood passes from it to the numerous fine blood-vessels or rather blood-spaces, for they have no definite walls, in the roof of the pulmonary chamber. The efferent pallial vein that collects blood from the mantle and returns it to the heart is on the opposite or left side of the mantle-cavity. It is a direct continuation of the auricle and can easily be traced forward in the left corner of the mantle-cavity, running along the upper border of the left columellar muscle (Pl. XXXII. fig. 16, *v. pal.*) nearly as far as the thick muscular anterior border of the mantle. It receives numerous vessels from the mantle, especially in the anterior part of its course. The blood from the intestinal and perigastric sinuses does not pass straight to the mantle, but is collected into a large sinus provided with definite walls (Pls. XXXIII. & XXXIV.

figs. 19 & 21, *v. ren.*), whence it passes by an afferent renal vessel to the glandular portion of the kidney. So far as I can ascertain, the blood is returned from the kidney to numerous small vessels running in the floor of the posterior half of the mantle-cavity, and is conveyed from these to the auricle by a distinct vein (Pl. XXXIII. fig. 20, *v. post.*) which opens into the hinder part of the auricle, and receives in addition blood from the roof of the extreme hind end of the roof of the mantle-cavity. There are thus two distinct vessels opening into the auricle, the foremost of which brings back blood from the roof of the greater part of the pulmonary chamber; the hindmost brings blood that has passed through the kidneys, then through the vessels on the floor of the pulmonary chamber, and in addition a small quantity of blood from the roof of the extreme hind end of the pulmonary chamber.

The Excretory Organs.

The topographical relations of the kidney, as compared with that of the Neritidæ, have already been explained (p. 765). Regarded in detail, the kidney consists of a thick-walled glandular portion and a thin-walled non-glandular portion which serves as a bladder and urinary duct. The glandular portion is a large and, roughly speaking, quadrangular sac lying in the lower part of the visceral mass, below the stomach but above and somewhat to the left of the lower loop of the rectum. Its posterior and left wall fits closely against the pericardium and forms the inner boundary of the latter. The two ends of the sac are produced into large pockets or recesses, which partly extend round and embrace the walls of the pericardium (Pl. XXXIII. figs. 18 & 19), and partly extend upwards round the sides of the pyloric division of the stomach (Pls. XXXIII. & XXXIV. figs. 17 & 24). The cavity of the sac is spacious, and only partially subdivided by folds projecting inwards from the wall on the pericardial side; the opposite wall is not folded. The renal blood-vessels run in these folds.

The whole cavity, including the folds, is lined by a uniform glandular epithelium consisting of large irregularly shaped cells, of varying length, their free ends rounded or club-shaped and often projecting far into the lumen of the sac.

The characters of these cells are shown for *Alcadia* in fig. 22 and for *Lucidella* in fig. 23 (Pl. XXXIV.). In all the other species that I have examined the kidney-epithelium resembles that of *Lucidella*; it is only in *Alcadia* that the cells are as long, irregular, and amœboid-looking as those drawn in fig. 22. In both cases the cytoplasm is clear and distinctly and coarsely vacuolated; the nucleus spherical, vesicular, with a few granules of chromatin. The ureter or non-glandular part of the kidney arises from the upper corner of the left-hand recess of the glandular sac. Its walls are composed throughout of a non-ciliated, very low, cubical epithelium, the cells of which are so much flattened that they might almost be called a pavement-

epithelium. The ureter is a widish tube which after leaving the glandular sac turns back to run round the hinder wall of the pericardium, interposing itself between it and the lower surface of the visceral mass. After passing from the left to the right side it mounts upwards again, passes under the reno-pericardial canal, and opens into the right-hand side of the mantle-cavity by a thick-lipped slit-like uropore. As is shown in fig. 23, the mantle-epithelium is invaginated at the lips of the uropore, and this invaginated portion is ciliated, but there is no uropore-sac such as I have described in the Neritidæ.

The reno-pericardial canal (figs. 19 & 22) opens out of the lower part of the right-hand recess of the glandular part of the kidney, and runs straight into the right side of the pericardium opposite the middle of the expanded base of the auricle. The canal is short, straight, and narrow, lined by a cubical ciliated epithelium, the component cells of which are small and bear no resemblance to the very large ciliated cells lining the long twisted reno-pericardial canal of the Neritidæ. The cilia are fine and directed towards the kidney. A thickening of the epithelium at the pericardial opening of the canal is suggestive of the presence of a pericardial funnel. The structure and relations of the kidney and the reno-pericardial duct are remarkably uniform in all the species of Helicinidæ that I have examined.

The Generative Organs.

Thiele (10) has shown that the female ducts are monaulic in *Hydrocena cattaroensis*, but diaulic in *Helicina kubaryi*. Before my memoir on the Neritidæ was published I had discovered the diaulic ducts in *Alcadia* and *Eutrochatella*, but, as I omitted to make mention of them in that place, I must yield priority to Thiele, whose diagrammatic figure (*loc. cit.* text-fig. 2) gives a correct representation of the general relations of the various subdivisions of the ducts. But it is almost impossible to construct a life-like picture of such complicated organs from a study of sections, and as I have dissected out the gonaducts, both male and female, in a number of species and have checked my observations by the study of sections, I may be pardoned for again taking up the subject and entering into it at some length. From the analogy of the Neritidæ, in which family the gonaducts exhibit a considerable range of variation, I expected to discover equally great differences in these organs in the various genera of Helicinidæ, but have been disappointed. There are differences, it is true, but they are slight and do not throw much light upon the systematic affinities of the various genera studied.

The gonads in all Helicinidæ lie above and to the right side of the liver. The ovaries are follicular, and the follicles open into a large thin-walled chamber which in *Alcadia* and *Eutrochatella* is situated on the right side of the visceral mass, just behind the posterior end of the right columellar muscle and in front of the

muscular partition separating the visceral cavity from the complex glandular mass formed by the hypobranchial gland and gonaducts (Pl. XXXVI. fig. 32). The ova appear to go through their maturation-phases in this chamber, as no ripe ova are to be seen in the follicles. In *Alcadia* and *Eutrochatella* this ovarian chamber is sac-shaped and on the right side of the body, but in Pacific and Oriental species, such as *Palæohelicina ida*, *Orbophana ponsonbyi*, and *Aphanoconia gouldiana*, the ovarian chamber is produced into a wide tube which stretches transversely across the body and receives the products of the follicles of a left ovarian lobe, the latter being a distinct triangular lobe, projecting from the surface of the visceral mass and packed close under the left columellar muscle. This lobe is possibly characteristic of Pacific and Oriental species: it is absent in *Alcadia*, and scarcely represented in *Eutrochatella*. My specimens of *Lucidella* were all male, and therefore I cannot say whether it occurs or not in this West Indian genus. The female gonaducts of *Alcadia hollandi*, which are to all intents and purposes identical with those of *A. palliata*, are depicted in Pl. XXXV. fig. 25; and figs. 30 to 35 (Pls. XXXV. & XXXVI.) represent selected sections from a series passing horizontally through the genital complex of a female of the same species, fig. 30 being the uppermost and fig. 35 the lowest of the series.

Dealing first with the macroscopical characters, the following organs or parts can be distinguished, and as their shape and relative positions are clearly indicated in fig. 25 a detailed description will be superfluous. (1) The oviduct *od.* is a very narrow duct leading from the ovarian chamber to (2) the dilated or V-shaped portion of the oviduct, in which a descending limb (*od.*¹) and an ascending limb (*od.*²) can be recognized. In *Alcadia* the ascending limb is as long and of approximately the same diameter as the descending limb: in its lowest third it receives the short and narrow duct of a globular receptaculum seminis. (3) The ootype, *oot.*, is a long, more or less dilated glandular duct running parallel with the rectum in the right hand of the roof of the mantle-cavity, and opening into the latter on the right side by a relatively narrow aperture on a papilla which lies in a sort of shallow cloaca formed by the expanded lips of the rectal opening. Into the posterior end of the ootype open: the ascending limb of the V-shaped part of the oviduct; the cæcum of the ootype, a sac-shaped structure of considerable relative size, which lies parallel to and to the inner side of the V-shaped duct; thirdly, the short and rather narrow duct of (4) the vagina, *vag.* The last named is a slender duct with thin walls, opening into the mantle-cavity close to the aperture of the hypobranchial gland. It is continued posteriorly into a sac, which runs back on the outside of the V-shaped duct and ends blindly (this sac has been displaced in fig. 25 to show it more clearly, in its natural position it would be concealed by the V-shaped duct). It may be called the vaginal sac. Comparing these ducts with those of the Neritidæ, particularly with *Paranerita* (2, fig. 60), it is clear that the ootype is

homologous in the two forms, as is also the vagina. The vaginal sac of *Alcadia* corresponds to the spermatophore sac of *Paranerita*, but in the former genus the duct connecting the vagina with the ootype has been shortened to such an extent that it is merely a passage between the two. The V-shaped duct of *Alcadia* is only a modification of the oviduct and has no exact homologue in *Paranerita*; the position of the receptaculum seminis is also somewhat different. There is no trace of an oviduco-celomic funnel in any Helicinid, nor is there any representative of the crystal-sac. On the other hand, the cæcum of the ootype is not represented in the Neritidæ, for it would be straining homology too far to suggest that it is the equivalent of the lower dilated part of the ductus enigmaticus. But if the morphological comparison between the female gonaducts of the Neritidæ and Helicinidæ is fairly obvious, a physiological comparison is by no means so clear. In the specimen of *A. hollandi* whose ducts are drawn in fig. 25 the hinder moiety of the ootype was filled and greatly distended by a large mass of spermatozoa held together by a coagulable substance, and, as shown in the figure, a string of the same mass of spermatozoa and coagulum extended into and filled the cæcum of the ootype. The vaginal sac was empty, but the receptaculum was full of spermatozoa. This suggests that the "ootype" is the copulatory canal or functional vagina, and that the "vagina" may serve for the passage of the ova into the mantle-cavity. But the probability of such a conclusion is lessened by the fact that in *Aphanoconia merguiensis* and *A. gouldiana* I found the vagina and vaginal sac full of spermatozoa. I have not found ova either in the oviduct or in the ootype of any of my specimens; and apparently in the Helicinidæ fertilization is not effected by means of spermatophores, for I have found no trace of such structures. The mass of spermatozoa and coagulum in *Alcadia hollandi* cannot be called a spermatophore. The evidence as to the function of the several parts being slender, and what there is conflicting, I offer no definite theory on the matter, but may add that the "vagina" is evidently a distensible duct, as it has thin walls, with a very feeble coat of circular muscle-fibres, but with a number of muscular slips passing from its walls to be attached to adjacent organs. On the other hand, the ootype has a thick muscular coat, especially in its hinder moiety, and the contraction of this muscular coat would expel any contained material through the external aperture.

A comparison of the gonaducts of the several genera shows certain differences in detail. The female gonaducts of *Eutrochatella*, a West Indian genus, are shown in Pl. XXXV, fig. 26. Their arrangement is clearly very similar to that of *Alcadia*. The ascending limb of the V-shaped duct is shorter in *Eutrochatella* and has more the appearance of a direct posterior continuation of the ootype. The receptaculum seminis is small and ovoid, but in the same position as in *Alcadia*. The vagina is short: the vaginal sac of moderate length. The cæcum of the ootype is a large

flattened sac and extends some way behind the posterior end of the V-shaped duct.

Of the Pacific and Oriental genera, *Aphanoconia* (Pl. XXXV. fig. 27) most nearly resembles *Alcadia* and *Eutrochatella*. The descending limb of the V-shaped duct is large; the ascending limb short and scarcely differentiated from the hinder end of the ootype; it bears a relatively large globular receptaculum seminis. The vagina is fairly long, and opens by a very short transverse duct rather high up into the ootype. The vaginal sac is short. There is no cæcum to the ootype. The female ducts are very similar in all the four species of *Aphanoconia* that I have examined, differing chiefly in the relative length of the vaginal sac and the position of the vagino-ootypal connection.

On the other hand, *Palæohelicina* (fig. 28) and *Orobophana* (fig. 29), while resembling one another, differ in some important respects from the West Indian genera and from *Aphanoconia*. In *Palæohelicina idæ* the ascending limb of the V-shaped duct is wide and scarcely differentiated from the hinder end of the ootype. There is no receptaculum seminis, but the ootypal cæcum is large, bilobed at its extremity, lined by an epithelium of peculiar character, and filled with spermatozoa. It evidently functions as a receptaculum seminis. The vagina and vaginal sac are normal. In *Orobophana ponsonbyi* the descending limb of the V-shaped tube is unusually long; the ascending limb very narrow and short, and does not bear a receptaculum seminis. The cæcum of the ootype is large, bilobed, full of spermatozoa, and in every respect similar to that of *Palæohelicina*. The vagina is long; the vaginal sac leaves it about halfway between its external aperture and its connection with the ootype.

I am unable to give a description of the female organs of *Lucidella aureola*, as all my specimens were males.

Summing up the above facts, we see that as regards the structure of the gonaducts there are two types in the genera dealt with. In the first type there is a receptaculum seminis on the ascending limb of the V-shaped duct. This type is divisible into two sub-types: the one, found in *Alcadia* and *Eutrochatella*, is characterized by the large cæcal appendage of the ootype; the other, found in *Aphanoconia*, has no such cæcum. In the second type, represented in *Palæohelicina* and *Orobophana*, there is no receptaculum seminis on the ascending limb of the V-shaped duct, but this organ is replaced functionally by the modified bilobed cæcum of the ootype. According to Wagner (12) *Palæohelicina* stands nearest to *Helicina* sensu restricto, and therefore nearer to *Alcadia* than other Oriental and Pacific forms, but in the structure of the female gonaducts, *Aphanoconia* stands nearest to *Alcadia*, but *Palæohelicina* with *Orobophana* stand somewhat apart.

The gonaducts of the Helicinidæ evidently undergo great histological changes at the onset of sexual maturity. In sections of immature females of *Alcadia* and *Eutrochatella* the ootype is a

relatively narrow tube lined by a columnar epithelium, in which glandular elements are hardly recognizable, and there is a similar lack of differentiation of glandular cells in the V-shaped duct. On the approach of sexual maturity the epithelium of the ootype is enormously thickened, is rich in glandular elements, and is thrown into complicated folds; at the same time, histological changes occur in the V-shaped duct. In the breeding-season, when the ootype is distended as shown in fig. 25 (Pl. XXXV.), the epithelial folds of the ootype disappear, the gland-cells have discharged their contents, and the epithelium appears shrunken and thinner than before. In consequence of these changes, it is difficult to give a consistent account of the histological characters of the ducts: what follows is based on a series of sections of a mature specimen of *Alcadia hollandi*, in which the tissues, thanks to Mrs. Longstaff's care, are admirably preserved.

In the distal half of the ootype, that is in the portion marked *a* in fig. 25, the epithelium is moderately long and of the mixed glandular and ciliated kind. The ciliated cells are elongate columnar, not much attenuated at their bases, their cytoplasm clear and very finely granular, their nuclei rather large, oval, situated rather to the basal side of the middle of the length of the cell. The gland-cells are of nearly the same shape, but of rather greater diameter than the ciliated cells, their nuclei slightly larger, situated nearer the bases of the cells, and the cell-body filled with rather small highly refracting spherules of a greenish-yellow colour in preparations stained with hæmatoxylin and eosin. The hinder moiety of the ootype—namely, that portion filled with the mass of spermatozoa in fig. 25—shows somewhat different characters. The supporting epithelial cells are, as before, columnar and finely granular, but of greater length: they appear to have lost their cilia over the greater part of the inner wall of the ootype and to end distally in rounded and somewhat vacuolated extremities, but as I can find cilia in patches this appearance may be due to maceration. The gland-cells in this region (Pl. XXXVII. fig. 36) are not very abundant, but characteristic, and presumably mucinogenous as they stain deeply in hæmatoxylin. Their basal ends, resting on the basal membrane, are broad and in each is a rather small subspherical nucleus, above which the cell tapers to a fine tube filled with a darkly staining granular material: these attenuated cell-bodies run between the supporting cells and terminate in swollen extremities filled with coarse deeply staining spherules. Throughout this region of the ootype the epithelium is thrown into ridges and furrows, which are partly due to the folding of the walls, but chiefly to the unequal length of the epithelial cells. At the hinder end the folds increase and there is a prominent valve projecting into the lumen and making a complete spiral turn just above the opening of the V-shaped duct. This opening, guarded by the above-mentioned valve, is narrow. The upper part of the V-shaped duct is lined by an epithelium of the same character as that of the hinder moiety of the ootype, the

supporting cells being here distinctly ciliated and the deeply staining mucinogenous cells conspicuous. This epithelium is thrown into a distinct spiral ridge, which winds round the upper part of the V-shaped duct nearly as far as the entrance of the duct of the receptaculum seminis. Here the epithelium changes its character; the deeply staining mucinogenous cells disappear and give place to very numerous long tubular gland-cells with large oval basal nuclei, the tube-shaped cell-body coarsely alveolar and the alveoli containing large refringent non-staining spherules. Wedged between these are the ciliated cells, with elongated nuclei at about the middle of their length, very attenuated basal ends, and somewhat expanded wedge-shaped distal ends, each with a distinct striated border and a tuft of fairly long cilia. The receptaculum seminis (Pl. XXXVII. fig. 37) is lined by a low columnar ciliated epithelium of uniform character. The cell-bodies are finely granular and stain readily; the nuclei spherical and deeply staining. Each cell has a distinct striated border and bears a tuft of long coarse cilia. The spermatozoa in the receptaculum are all arranged with their heads directed towards the centre, their tails outwards and entangled among the cilia of the epithelium. The receptaculum and its duct are invested by a very stout coat of muscular fibres.

The transition from the upper end of the ascending limb of the V-shaped duct to the narrow tube of the oviduct is abrupt. The oviduct is lined throughout by an epithelium consisting of long columnar cells bearing specially long and coarse cilia. The characters of these cells are shown in fig. 38 (Pl. XXXVII.).

The cæcum of the ootype is lined by an epithelium differing from that of the rest of the ootype in the absence of glandular cells. The walls of the cæcum, like those of the hinder moiety of the ootype itself, are provided with a tolerably thick coat of muscular fibres, mostly disposed circularly. The muscular coat is not folded, but the epithelium is disposed in longitudinal ridges due, as seen in fig. 39 (Pl. XXXVII.), to the greater length of the cells composing them: this figure is from *Orobophana ponsonbyi* and not from *Alcadia*; in the latter genus the cells are somewhat longer and more slender, but otherwise similar in character. As is shown in the figure, the cells are club-shaped with rounded ends projecting into the lumen of the cæcum; they do not bear cilia. It is the presence of this characteristic epithelium in the bilobed sac full of spermatozoa leading into the hinder end of the ootype in *Palæohelicina* and *Orobophana* which leads me to identify the sac in question with the cæcum of the ootype of *Alcadia* and *Eutrochatella* rather than with the receptaculum seminis, and it is further to be remarked that in the non-ciliated bilobed sac the spermatozoa are arranged pell-mell, with their heads and tails in all directions instead of being definitely oriented as they are in the ciliated receptaculum seminis.

The distal third of the vagina is lined by an epithelium consisting for the most part of highly vacuolated clear cells with basal nuclei,

and between these are very attenuated supporting cells. I could not detect any cilia on the latter.

The proximal two-thirds of the vagina and the vaginal sac are lined by a non-ciliated epithelium of uniform character, the details of which were not well preserved in my sections of *Alcadia* and *Entrochatella*: apparently they had been injuriously affected by the action of Perenyi's fluid. In *Orobophana ponsonbyi* the epithelial cells of the lower part of the vagina and of the vaginal sac are squarish in outline, non-ciliated and clearly glandular, for each contains a number of coarse non-staining spherules. The cavity of the sac contains a number of spherules of similar character and among them ropy masses of some coagulable substance staining faintly in hæmatoxylin.

In *Orobophana* the epithelial lining of the ootype differs in some respects from that described for *Alcadia*. The supporting cells are attenuated towards their bases, have long compressed nuclei about the middle of their length, and are distinctly ciliated. The gland-cells of the distal part of the ootype resemble those of *Alcadia*, but are apparently differentiated to some extent, for the granular contents of those on the inner side of the ootype nearest the mantle-cavity are eosinophilous, those on the outer side are not. Just above the entrance of the vaginal duct the eosinophilous cells are replaced by mucinogenous cells staining deeply in hæmatoxylin. A large spiral flap or valve separates the opening of the cæcum from that of the ascending limb of the V-shaped duct. The last named is very narrow and invaginated for some distance into the terminal part of the ootype: it has no spiral epithelial fold, such as is seen in *Alcadia*. The gland-cells of the distal limb of the V-shaped tube are highly eosinophilous.

Thiele (10) has shown that the female ducts of *Hydrocena* are monaulic. The external aperture leads into a thick-walled glandular duct, which is clearly homologous with the ootype of the Helicinidæ. The lumen of this duct is continued posteriorly into a fairly wide canal lined by a columnar epithelium devoid of glandular cells, and this ends in a saccular dilatation of considerable size, which is apparently glandular; "sein Epithel enthält Klümpchen von Körnchen." Thiele identifies this sac and its duct with the vaginal sac and vagina of *Helicina*, and regards it as the homologue of the right kidney of the Trochidæ, which in this case has not acquired an independent opening into the mantle-cavity. In addition to this sac, three other structures open into the hinder end of the "ootype" in *Hydrocena*: on the right a thick-walled glandular cæcum; on the left the oviduct; and between the two and dorsad of the "right kidney sac" a tubular receptaculum seminis. Thiele's homologies seem to be perfectly just, and after his discovery of the conditions obtaining in *Hydrocena*, I must agree with him in regarding the vaginal sac of the Helicinidæ and the spermatophore sac of the Neritidæ as the representatives of the right kidney. But I still beg leave to differ from his interpretation of the vaginal aperture as the

primitive aperture of the right kidney, and of the external aperture of the ootype as a secondarily acquired separate genital duct. The conditions in *Hydrocena* appear to me to be an ample justification of the argument put forward in p. 873 of my memoir on the Neritidæ. *Hydrocena* is in many respects more primitive and therefore more nearly related to the ancestral Neritoid stock than the Helicinidæ, and Thiele himself points to the generative organs as one of the evidences of primitive organization.

In his memoir entitled "Die systematische Stellung der Solenogastren und die Phylogenie der Mollusken" (9) Thiele, after describing the male organs of *Septaria*, gives the following account of the male organs of *Helicina* (= *Waldemaria* Wagner) *japonica*: "Bei *Helicina* ist der männliche Geschlechtsapparat merklich einfacher, der Samengang ist nur sehr wenig aufgeknäuelte und weiter, er mündet in den Drüsengang von unten und rechts nicht weit vor seinen Hinterende. Der letztere ist bedeutend einfacher als bei *Navicella*, durch Falten streckenweise etwas zertheilt, doch scheint das drüsige Epithel trotz geringer Verschiedenheiten an manchen Stellen in Wesentlichen gleichartig zu sein. Die Drüsenzellen liegen durchweg zwischen den Stützellen. Dieser Gang reicht weit nach vorn in der Mantelhöhle doch habe ich ein besonderes Kopulationsorgane nicht wahrgenommen. Die ektodermale Drüse, welche rechts von Hinterende des Drüsenganges (Prostata) in die Mantelhöhle ausmündet, erstreckt sich, in dem sich allmählich grosser wird, weit nach hinten, wo sie neben dem Hinterende der Niere aufhört. Nach ihrem Bau ist an ihrer ektodermalen Herkunft nicht zu zweifeln, da sie zwischen den grobkörnigen Drüsenzellen deutliche Stützellen enthält. Sie mag als eine Art von Manteldrüse ähnlich der Hypobranchialdrüse anzusehen sein: ihre Funktion ist unbekannt."

The ectodermal gland referred to in this passage I have already described as the hypobranchial gland, fully agreeing with Thiele's interpretation of it. It has no connection with the generative organs. In the six genera that I have examined the male ducts are, with the exceptions to be mentioned hereafter, very much alike, but not quite so simple as Thiele's description would lead one to suppose, and presumably *Waldemaria japonica* has undergone some simplification in these organs, for so accurate an observer cannot have overlooked the accessory organs that I am going to describe.

The testis, like the ovary, is follicular in structure; fine thin-walled ducts converge from the follicles and unite in the right side of the visceral mass to form the sperm-duct. The last-named organ occupies a position similar to that of the oviduct in the female: in immature specimens it is slender, slightly convoluted, and lined by a columnar ciliated epithelium. In mature specimens its middle portion is greatly distended by spermatozoa, is considerably convoluted, and the ciliated epithelial lining is no longer distinguishable. The sperm-duct tapers somewhat and, as Thiele describes, opens into the lower and right side of a long glandular

thick-walled sac, some little distance in front of the hinder end of the latter. This thick-walled sac, which is evidently the representative of the ootype of the female and of what I have called the terminal chamber in the Neritidæ, runs forward in the roof of the mantle-cavity, below and to the right side of the rectum, and opens into the mantle-cavity by a terminal pore situated close to the anus. At about one-third of its whole length from the external aperture, the thick-walled sac—which I shall call the terminal sac of the sperm-duct or, more shortly, the terminal sac—is joined by another sac of considerable diameter. This second sac, which I shall call the diverticulum, opens into the terminal sac by a wide aperture, and runs back close to the right side of the latter, to end blindly, sometimes just in front of the entry of the sperm-duct into the terminal sac (*Aphanoconia gouldiana*, Pl. XXXVII. fig. 41); in other cases, however, it extends as far back as the hinder end of the terminal sac, and may even project a little beyond it (*Alcadia hollandi*, fig. 40). The anterior third of the terminal sac, in front of the entry of the diverticulum, exhibits three or four deep transverse constrictions: in section it is round or oval, and the lumen is partly occluded by deep longitudinal folds projecting into it. These folds are covered by a mixed glandular and ciliated epithelium: the ciliated cells of the familiar kind with attenuated basal ends, the gland-cells tubular with basal nuclei and vacuolated cell-bodies, in which no secretory granules could be distinguished in well-preserved specimens of *Eutrochatella*. In its posterior two-thirds the terminal sac is laterally compressed so as to be elongate oval in section, and it gives off from each end of the oval and from the adrectal side numerous short hollow cæcal outgrowths which are sometimes branched, especially in *Aphanoconia* (fig. 41). Internally the longitudinal epithelial ridges die out in the posterior two-thirds of the terminal sac, but the epithelial lining both of the cavity of the sac and of the cæcal outgrowths is of very nearly the same character as that of the anterior third. The supporting cells are distinctly ciliated. The epithelium of the diverticulum differs from that of the terminal sac only in the fact that the gland-cells are full of eosinophilous granules, and the cilia of the supporting cells are longer and rather coarser. The above characters hold good for all the species that I have examined, the differences between them being too slight to deserve mention. It may be noted that in *Alcadia* the hinder moiety of the diverticulum is constricted at very regular intervals (Pl. XXXVII. fig. 40). Both in *Eutrochatella* and *Lucidella* I have found in sections a second diverticulum in the form of a slender thin-walled tube opening into a recess of the terminal sac at the same level as, but on the opposite side to, the diverticulum above described. The walls of the recess are lined by a glandular epithelium staining deeply in eosin. The narrow tube runs back in the mantle-wall nearly parallel to the terminal sac and ends blindly just in front of the aperture of the hypobranchial gland. Its hinder end touches and appears to be adherent to the sub-epithelial muscular

wall of the mantle-cavity, but there is no aperture into the mantle. I have not been able to find this tube in other species, but this may be due to the imperfection of my sections and to the fact that it is too small to be recognizable in dissections. It is a well-defined structure in *Eutrochatella* and is lined throughout by a non-glandular cubical epithelium. I am inclined to the opinion that the anterior third of the terminal sac of the male is the equivalent of the body of the ootype of the female; the diverticulum of the male represents the cæcum of the ootype, and the narrow tube (Pl. XXXVII. fig. 42, *k.r.*) represents the vagina of the female, but has lost its opening into the mantle-cavity. If this identification is correct, a relic of the right kidney-sac is retained in the male, at least in *Eutrochatella pulchella* and *Lucidella aureola*.

It may be noted that Isenkrahe's drawing of the male organs of *Helicina titanica* is very nearly correct.

The Nervous System.

Nobody has given a detailed account of the nervous system of any Helicinid since Bouvier dealt with this subject in his classical memoir on the nervous system of Prosobranch Gastropods (3). In that work he gives an elaborate figure of the nerve-centres and principal nerve-trunks of *Helicina sagraiana* d'Orb., and also several figures of the buccal ganglia of the same species and of the cerebral and pleuro-pedal centres of *H. brasiliensis* Gray. As is always the case, Bouvier's figures possess a high degree of accuracy, and if I have some criticisms to offer, they must not be taken as depreciatory of his excellent work, but as an elaboration of it, rendered possible by careful study of sections and by the opportunities for exceedingly fine dissection afforded by the Braus-Drüner microscope.

In the first place, it was necessary to determine whether the supra-intestinal nerve exists in the Helicinidæ. Bouvier had failed to find it in the Neritidæ, and when in a subsequent memoir he announced its discovery in the latter group, he hazarded the opinion that it would probably be found in the Helicinidæ. But it does not exist in these pulmonate rhipidoglossates; it has disappeared in them as completely as the organs with which, when present, it is associated, the ctenidium and the osphradium. I can speak with certainty on this point, for I have made so many dissections and have studied such a sufficient number of serial sections that I could not have overlooked it if it were present.

In the second place, I am unable to verify some of the details of Bouvier's figure of the nervous system of *H. sagraiana*. In none of the species that I have studied are the pedal, pleural, and subintestinal centres as distinct as shown by him. As may be seen in fig. 44 (Pl. XXXIX.), the pleural ganglia are ill-defined swellings, scarcely distinguishable from the swollen anterior ends of the pedal cords, and the subintestinal ganglion is so intimately fused

with the pleurals that it is unrecognizable as a separate ganglion, even in sections (Pl. XXXVIII. figs. 45 to 52). The pedal cords, though not so widely separated in any of the species of Helicinidæ that I have dissected as in the Neritidæ, are not so closely approximated as shown in Bouvier's figure. They are fairly close together and nearly parallel to one another in *Eutrochatella pulchella*, somewhat more divergent in *Alcadia hollandi*, further apart in *A. palliata*, and widely divergent in *Aphanoconia andamanica*. The actual amount of divergence or approximation is, however, undoubtedly dependent on the degree of contraction of the muscular mass of the foot, and is a character of no great importance. If the foot is much contracted the pedal cords are approximated and the numerous and slender pedal commissures are arched; if the foot is relaxed the cords are further apart and the commissures are pulled out straight. I cannot but think that Bouvier has exaggerated the length of the cerebro-pleural and cerebro-pedal connectives. In none of the species that I have examined are they appreciably longer than the antero-posterior diameter of the cerebral ganglia, and in some species, e. g. *Lucidella aureola*, they are very short, but it is, of course, possible that they are unusually long in *H. sagraiiana*. In respect of the nerves issuing from the ganglionic mass formed by the fusion of the anterior ends of the pedal with the pleural centres, Bouvier, while otherwise exact, makes one important omission. He does not figure or describe a relatively large pair of nerves which originate one on each side of the most anterior pedal commissure from the dorsal surface of the swollen anterior ends of the pedal cords. Each of these nerves (Pl. XXXIX. figs. 43 & 44, *n.op.*) passes outwards and backwards, penetrates the muscular wall of the body, and passes to the muscles of the operculum, hence the nerves in question may be called the opercular nerves. That of the right side breaks up into a number of fine twigs in the opercular muscles, that of the left side gives off a stout branch which passes to a peculiar hollow organ connected with a plate of cartilage near the left corner of the opercular lobe. This organ will be described in detail further on.

The otocysts are situated just above the origins of the two opercular nerves, and are therefore on the *dorsal* side of the pedal ganglia, as is shown in fig. 44. Bouvier, describing the otocysts of *Helicina brasiliensis* says "elles sont situées sous les cordons pedieux"; and it is true that in a retracted specimen, in which the head has been drawn back behind the foot, so that the pedal cords appear to lie in front of the cerebral ganglia, one does find the otocysts below the pedal cords, when making a dissection from the dorsal side. But in such a case the sole of the foot is uppermost, and the morphologically dorsal side of the pedal cords is turned downwards, this change of position being very puzzling to the observer both in sections and dissections. It is worth remarking in this connection that in my experience the small Polynesian genera, *Aphanoconia*, *Palæohelicina*, and, in

a lesser degree, *Orobophana*, when they withdraw themselves into their shells, do not contract themselves as much as the West-Indian species. The sole of the foot in these Polynesian genera is longer and narrower than in the West-Indian genera, the columellar muscles longer and inserted further back from the mouth of the shell. There is therefore more ample room for the head and foot in the last whorl of the shell, and when the animal retracts itself the foot is scarcely at all contracted, but simply slides back with its sole applied to the outer side of the shell till the operculum borne on the broad opercular lobe closes the aperture. Specimens of these genera, when extracted from their shells, do not present the deformed appearance of an *Alcadia* or an *Eutrochatella*, the pedal nerve-cords are not turned forward with their morphological surfaces reversed, and if the animals were only a little larger they would be much easier to dissect than their American congeners. It is possible, and even probable, that these different modes of retreating into the shell, which are themselves dependent on the varying length and points of insertion of the columellar muscles, are correlated with the different forms of operculum upon which Wagner has founded his system. At any rate, they are consistent with it, but I have not been able to follow out this problem in detail.

To return to the nervous system. The opercular nerves must not be mistaken for the parietal nerves correctly described and figured by Bouvier and labelled *d'*, *e'*. The parietal nerves (Pl. XXXIX, fig. 44, *n.par.*) are much more slender than the opercular nerves and originate, as shown in fig. 44, from the pleural centres, between the great pallio-columellar nerves and the cerebro-pleural connectives. They pass to the muscular walls of the head behind the tentacles. From the ventral side of the swollen anterior ends of the pedal cords, in the same cross-section as the opercular nerves, a rather stout pair of nerves originates near the middle line; these nerves, which are shown in section in fig. 46 (Pl. XXXVIII.), pass to the pedal gland and appear to be specially connected with that organ.

As regards the subintestinal nerve and its distribution, I am unable to bring my observations into agreement with those of Bouvier. The short nerve connecting the subintestinal with the left pallio-columellar nerve-trunk does not appear to be a constant feature. I have found such a connective in a single specimen of *Alcadia palliata*, and in that one instance it is much closer to the pleuro-pedal centres than is shown by Bouvier. But I can find no trace of it in any other specimen that I have examined. I am unable to find any trace of the visceral nerve labelled *j'* in Bouvier's figure, which he describes as given off from the left side of the subintestinal at some distance from the origin of the latter, and in general my observations on the subintestinal and visceral nerves differ so much from his that a detailed account is necessary. The figure illustrating this account (Pl. XXXIX, fig. 43) is founded upon dissections, and the ultimate ramifications of the principal

nerve-branches have been traced in sections. The subintestinal trunk in *Alcadia palliata*, *A. hollandi*, and *Eutrochatella pulchella*, after leaving the subintestinal ganglion, which latter is unrecognizably fused into the pleural centres, courses along the floor of the anterior division of the general body-cavity, below the pharyngeal bulb, the radular sac, and œsophagus. It keeps closer to the right than to the left columellar muscle, and on reaching the posterior end of the muscle it doubles the angle between it and the visceral mass, and entering the latter turns to the left and enlarges to form a ganglion of some size from which several nerves are given off. That this is a true ganglion-centre, and not a mere nodal thickening at a point from which several nerve-branches originate, is demonstrated by the considerable sheath of nerve-ganglion cells. The principal nerves issuing from the ganglion, in addition to the main trunk, are the following:—a small nerve, v^1 , which passes to the right near the surface of the visceral mass and is distributed to the gonads and liver. Another small nerve, v^2 , which passes to the left of the visceral mass and appears to innervate the right lobe of the liver and surface of the stomach. A stout nerve, *n.gen.*, which runs to the right, passes above the oviduct or sperm-duct, gives off a large branch to the mucous gland, and turns forward to break up into twigs on the posterior part of the complex of genital ducts: this is the genital nerve, and it identifies the ganglion from which it originates as the visceral ganglion. There is no separate genital ganglion as in the Neritidæ. The hinder end of the visceral ganglion is continued into a rather stout nerve, which may be regarded as the continuation of the main trunk of the subintestinal: this passes through the liver and below the small and large intestine, and turning towards the left it passes towards the lower border of the right moiety of the kidney, near which it enlarges to form a small but distinct ganglion, which I take to be the representative of the elongated visceral ganglion of the Neritidæ. From this ganglion small nerves are given off to the liver and kidney, and a larger nerve passes below the kidney, skirts the uropore, and can be traced beyond as far as the auricle of the heart, at which point it ceases to be recognizable. It is a matter of extreme difficulty to follow the above-mentioned nerves through the liver and intestinal coils by simple dissection, and I have only been able to make sure of their ultimate course by the study of serial sections.

After this criticism of the general characters of the nervous system, I may return to the consideration of some special details. The pleuro-pedal centres and with them the subintestinal ganglion are, as I have already said, so intimately fused as to be practically indistinguishable as separate ganglia. This fusion is brought out in a striking manner in sections. Figs. 45 to 52 (Pl. XXXVIII.) represent selected members of a series of nearly transverse sections through the pleuro-pedal centres of *Alcadia hollandi*. Fig. 45 represents a section through the pedal cords at the point where they begin to diverge from one another. Dorsad

of them are the otocysts, *ot.*; ventrad of them is the pedal gland. Each cord consists of a core of nerve-fibres and dendrites surrounded by a cortical layer of nerve-ganglion cells. The latter send in lateral horns at about the middle of the outer side of each cord in such a manner as to divide the central core into upper and lower moieties, which have been identified by French authors with the pleural and pedal sections of the cords respectively. This interpretation, however, does not appear to me to be well founded. Fig. 46 represents a section somewhat further forward than that in fig. 45; it passes through the hinder part of the anterior pedal commissure, and includes the roots of the two nerves of the pedal gland and of the right opercular nerve. The nerve-fibres of the former are seen to be supplied from two areas of the cortical layer lying respectively on the outer and inner sides of the ventral side of the cord. The opercular nerve receives its fibres partly from a centre on its own side, partly from a centre on the opposite side of the cord, the latter fibres crossing over in the commissure. Below them is a stout band of commissural fibres connecting the lateral horns of nerve-ganglion cells with one another. Above the median ventral raphe is a thick mass of nerve-ganglion cells. In a section somewhat further forward (fig. 47) the ventral raphe has disappeared and the mass of ganglion-cells above it is only represented by two small islets of nerve-ganglion cells, which are separated from the ventral surface by two well-defined bands of nerve-fibres starting from the ventro-lateral groups of nerve-ganglion cells and passing towards the centre partly decussate, partly sweep round the islets to curve round to the lateral horns of the ganglion-cells. Above these curved bands is the well-defined transverse commissural band of nerve-fibres, and above this again there is on either side a centre, consisting of nerve-fibres overlaid by a layer of ganglion-cells, which is seen to be connected with the origins of the opercular nerves. Above the nervous mass a pair of muscular cords passing from the otocysts towards the centre should be noticed.

In the next section (fig. 48), taken some little way further forward, the two little islets of ganglion-cells lying opposite the lateral horns are still visible. Below them are transverse bands of commissural fibres. Between them is seen the most anterior part of the decussating tract observed in the previous section. After decussation the fibres sweep out right and left to the dorso-lateral regions. In the mid-dorsal line is a deep and wide groove into which the muscular cords noted in the last section are entering. I regard the whole of the sections hitherto described as belonging to the pedal centres. The next section (fig. 49) shows that the dorsal groove containing the two muscular cords has been converted into a canal by the upgrowth and dorsal union of the nervous tissue. All that lies below this canal belongs to the pedal centres; all that lies to the sides of and above the canal belongs to the pleural centres.

In the pedal centres a prominent bundle of nerve-fibres is being formed on either side of the middle line: these when traced forward prove to be the origins of the cerebro-pedal connectives. Above them are the remains of the transverse anterior pedal commissure. Laterally, above the lateral horns of the ganglion-cells two other tracts of nerve-fibres are making their appearance: these have evidently received large contributions from the decussating fibres noticed in the previous sections, and when traced forward they prove to form part of the cerebro-pleural connectives. The central canal containing the two muscular cords is surrounded by a layer of nerve-ganglion cells, thickest on the ventral side, and above the canal are seen tracts of nerve-fibres originating from the lateral horns of either side and passing towards the middle line. Above them, again, is a small transverse band of commissural fibres, and above these a fairly thick layer of ganglion-cells, which, as may readily be seen by comparing this with the preceding sections, is something added to what was there before, and is, in fact, the layer of pleural ganglion-cells. The next three figures (50, 51, and 52) explain themselves. In fig. 50 the pedal centres are diminishing rapidly in volume. On the left side, which, owing to the sections being somewhat oblique, is rather behind the right side, a large tract of vertical nerve-fibres is seen passing from the pedal to the pleural centres. To the outside of this above the lateral horn are tracts of fibres some of which run upwards and will pass into the left pallio-columellar nerve, others will be continued into the right cerebro-pleural connective and the right parietal nerve. On the right side the origins of the cerebro-pedal and cerebro-pleural connectives are well defined. Between them lie the ganglion-cells of the lateral horn, and above the nucleus of the cerebro-pleural connective is a second lateral ingrowth of nerve-cells, belonging to the pleural ganglion. The pleural centre of nerve-fibres is well marked, and from it a stout band of commissural fibres passes above the central canal to the pleural centre of the other side. This is the pleural commissure, which I have already described in *Neritidæ*. Fig. 51 shows the cerebro-pedal and cerebro-pleural connectives in cross-section. The central canal with its contained muscular slips, having passed through the ring formed by the pleural and pedal centres, emerges as a groove on the ventral side. The origins of the right parietal and right and left pallio-columellar nerves are clearly visible, and it may be seen that both pleural centres are contributing fibres which, passing to the mid-dorsal line, form the origin of the subintestinal nerve. It should be observed that some fibres from the last named pass directly into the roots of the two pallio-columellar nerves. In fig. 52 the origin of the subintestinal nerve is distinct, and both it and the origins of the two pallio-columellar nerves appear to be imbedded in a mass of ganglion-cells in which the limits of the right and left pleural and the subintestinal ganglia can be traced with the aid of a little exercise of the imagination.

From what precedes, it follows that the pleuro-pedal centres are extremely complicated and are largely composed of definite tracts of nerve-fibres, some commissural, some decussating, some passing into the nerves issuing from this region. It is noticeable that there are several connections of a complex kind between the pleural and pedal centres as well as between the right and left pleural centres and the right and left pedal cords, and that there are evidences of numerous nervous relays throughout the region illustrated. No doubt, on analysis, these apparently complicated nerve-tracts can be reduced to five groups: (1) the pedal commissure, containing both direct and decussating tracts of fibres; (2) the pleuro-pedal connectives; (3) the cerebro-pedal and cerebro-pleural connectives; (4) the pleural commissure, peculiar to the Neritidæ and Helicinidæ; (5) the subintestinal connectives, derived from both right and left pleurals. Thus, the paths of the nerve-tracts might be described as normal, and consistent with our knowledge of the usual connections between the chief nerve-centres of Molluscs; but a study of sections will show that the arrangements are not so simple as might be inferred from a superficial examination of the ganglia and their commissures and connectives. For example, it appears that the cerebro-pleural connectives contain fibres derived from the pedal centres and that all the principal nerves contain fibres derived from two or more areas in the fused pleural and pedal ganglion-mass. I have been unable to pursue the subject further at the present time, and it is difficult to make any further progress because of our ignorance of the physiology of the molluscan nervous system. The main nerve-trunks must contain both afferent and efferent nerves, and it seems evident that these pass to different areas of the cortical layer of ganglion-cells, but as at present we have no means of distinguishing between these two kinds of fibres further analysis of the details of the nervous system is impossible. It may be of use to future workers on this subject to remark that there are two kinds of ganglion-cells in the cortical layer: larger cells with clear nuclei staining faintly in hæmatoxylin, and much more numerous smaller cells with deeply staining nuclei. It should be possible to trace the connection of the nerve-fibres with these different kinds of cells, but such an investigation demands fresh material, and could form no part of the present work on the Helicinidæ.

As Bouvier found considerable differences in the size and shape of the cerebral ganglia in *Helicina sagraiana* and *H. brasiliensis*, I have studied these centres with care in the hope that I might discover characters of classificatory value, but I have been no more successful here than I was in the case of the genital ducts. The characters to which Bouvier draws special attention are the relative size of the cerebral ganglia (enormous in *H. brasiliensis*); the size and shape of the labial lobe; the origin of the labio-proboscidian nerves, which all spring from the labial lobe in *H. brasiliensis*, but only one has this origin in *H. sagraiana*. As regards

the relative size of the cerebral ganglia I find that the proportion of each cerebral ganglion to the pleuro-pedal mass is expressed by the following figures:—in *Alcadia palliata*, $\frac{1}{2}$; *Alcadia hollandi*, $+\frac{1}{2}$; *Eutrochatella pulchella*, $\frac{2}{3}$; *Lucidella aureola*, $\frac{3}{4}$; *Palæohelicina ida*, nearly $\frac{1}{2}$; *Orobophana ponsonbyi*, $\frac{4}{5}$; *Aphanoconia gouldiana*, $+\frac{1}{2}$; *Aphanoconia rogersii*, $\frac{2}{3}$. The relative length of the cerebro-pedal and cerebro-pleural connectives varies greatly: they are longest in the two species of *Alcadia* and in *Palæohelicina ida*; of moderate length in *Orobophana*, *Aphanoconia*, and *Eutrochatella*; extremely short in *Lucidella aureola*. I have counted four labio-proboscidæan nerves on each side with more or less certainty in all the species examined with the exception of *Aphanoconia rogersii*, in which there appear to be five. Of these, counting from above downwards, the first and third are invariably stout nerves which branch soon after their origin; the second and fourth are slender and only divide into branches at their extremities. The labial lobe in all the species at my disposal has the form of a rounded boss projecting inwards from the antero-inferior edge of the ganglion: the shape and relative size of this lobe differ somewhat in the various species, but the differences are too slight to express in words. Fig. 53 (Pl. XXXIX.), representing the left cerebral ganglion of *Palæohelicina ida*, and fig. 54, representing the same ganglion in *Alcadia palliata*, show the extremes of difference in shape observed by me, and, on the whole, the cerebral ganglia of the Polynesian species resemble those of *Palæohelicina*, those of the West-Indian species those of *Alcadia*. The cerebral ganglia of the Helicinidæ, wedged in as they are between the anterior end of the pharyngeal bulb and the walls of the head, are nearly flat, the labial lobe projecting inwards beneath the pharyngeal bulb. Because of their flatness they are very readily stained and mounted as transparent objects, and figs. 53 & 54 give some idea of the complexity of the nerve-tracts and centres within the ganglion. One may distinguish an ocular centre, which is large relatively to the size of the ocular nerve, a tentacular centre, small relatively to the size of the tentacular nerve, and a relatively smaller commissural centre. Each of the labio-proboscidæan nerves has a more or less well-defined centre of its own, but the buccal and labial commissures have no distinct centres at their origin. There is, further, a median lobe which possibly serves as a relay for various nerve-tracts running into and around it. It is evident that the nerve-fibres of the cerebro-pleural connective make direct and intimate connection with the ocular and tentacular lobes, and that a stout band of fibres curves round from the root of the cerebro-pleural connective to the base of the labial lobe, receiving on its way an accession of fibres from the cerebro-pedal connective. This nerve-tract makes connections with the centres of origin of the buccal and labial commissures and the labio-proboscidæan nerves, and a well-defined curved band of fibres sweeps round from the origin of the first labio-proboscidæan nerve to enter the

cerebral commissure, the last named also having connections with the tentacular and median centres. Evidently, the cerebral ganglia have undergone a high degree of concentration and integration, but it is to be remarked that if the labial lobe as figured for *Alcadia* were pulled out towards the bottom of the picture, it would form an elongated labial process from which the labio-probosceidean nerves would be given off at intervals, as is the case in *Trochus* and *Turbo*. In other words, the labial lobe, as it seems to me, is represented, not solely by the little projecting boss from which the labial commissure originates, but by all that part of the ganglion that lies below a line drawn from the lower side of the origin of the cerebral commissure to a point just above the origin of the buccal commissure.

The buccal ganglia, with their commissures and the nerves originating from them, have been very correctly figured by Bouvier.

The organ which I have mentioned above as connected with a branch of the left opercular nerve is shown in section in fig. 55 (Pl. XL). It is deeply embedded in the muscular tissue of the opercular lobe and lies to the left of the anterior end of the lobe close to the origin of the left columellar muscle. It consists of a cartilaginous plate of subtriangular form, the edges of the anterior apex inrolled ventrally and eventually fused so as to form a short conical tube. This cartilage forms, as it were, the cover of a flattened sac (fig. 55, *sac*.) lined throughout by an epithelium which is thin and composed of a single layer of somewhat flattened cells on the side attached to the cartilaginous plate, but thick and composed of columnar cells bearing short stiff cilia on the opposite side. Anteriorly this is continued into the tube formed by the inrolled edges of the cartilaginous plate, and here the columnar ciliated cells form a nearly continuous lining to its cavity. Posteriorly, as shown in fig. 55, the ciliated cells forming the floor of the sac (the reader must understand that the figure is reversed, so that the ventral side is uppermost) rest on a thick basement-membrane, from which a broad band of muscular fibres spreads to be attached partly to the muscular wall of the left side of the neck, partly to the bands of muscular fibres passing over the otocysts. Into this muscular band the large branch of the left opercular nerve penetrates. Taking an anterior course this nerve gives off a branch to the opercular muscles, but its main trunk is directed towards the anterior tubular end of the organ under consideration, and there passes through a small perforation in the cartilaginous wall and is distributed to the ciliated columnar epithelium lining the cavity of the sac. Dorsally the cartilaginous plate is connected with the left columellar muscle by a stout muscular band passing obliquely outwards. Above this band are seen in fig. 55 the sections of two convolutions of a coiled glandular tube, which on the one hand communicates by a very narrow duct with the anterior tubular end of the above-mentioned sac, and on the other hand opens to the exterior,

near the left anterior edge of the operculum, between it and the membranous flap that surrounds the opercular lobe. This tube is lined throughout by a glandular epithelium composed of rather tall goblet-cells with deeply staining basal nuclei and clear cell-contents.

If, now, we enquire into the morphological significance of this peculiar organ, I think there can be little doubt as to its homology. It occupies the same position and receives the same nerve-supply as the crypt into which fits the curved process of the operculum in the Neritidæ. This process is no longer to be seen on the operculum of the Helicinidæ, but from a study of the muscular attachments in the two groups I am inclined to think that the cartilaginous plate described above represents its inner extremity, all direct connection with the operculum being lost. In connection with it new structures have been formed, viz. the sac and the glandular tube. What its physiological significance is it is hard to say. It is clear that, by contraction of the muscular bands attached to it, the sac may be widely dilated, and when dilated, air must flow into it through the glandular tube. The abundant nerve-supply and the character of the columnar epithelium bearing short stiff cilia suggest that the sac has a sensory function, and it is possible that it may be a special sense-organ, likely enough of an olfactory character, which enables the animal to receive impressions from the external world when retracted into its shell. For the opening of the glandular tube is in such a position that it would open to the outer air whenever the opercular plug was ever so little loosened.

The pedal gland, an organ which is absent in the aquatic Neritidæ, is largely developed in the Helicinidæ. Its position and general structure are roughly indicated in fig. 45 (Pl. XXXVIII.). It consists of a main duct below the pleuro-pedal nerve-mass and extending some little way but not far back below and between the pedal cords. The duct is lined by a columnar ciliated epithelium raised on the ventral side into two prominent ridges, one on either side of the middle line. Surrounding the duct are bunches of unicellular glands, which penetrate among the interlacing muscle-fibres of this region of the foot. Each unicellular gland is prolonged into a fine duct which passes between the epithelial cells of the main duct and opens into its lumen. The histology of this gland is reminiscent of that of the byssus gland of lamellibranchiate molluscs, described by me in another place. The main duct opens at the anterior end of the foot, in the mid line, below the snout.

Mention may be made here of the large mucous gland which I agree with Thiele in identifying as the hypobranchial gland. It is of relatively enormous size in the Helicinidæ, but in structure and position does not differ much from what I have described for the Neritidæ. It opens into the mantle-cavity (Pl. XXXV. figs. 28 & 30) just in front of the aperture of the vaginal duct and, as shown in figs. 30 to 35, it forms a considerable glandular mass bulging

into the mantle-cavity to the left side of the genital ducts. As may be seen in figs. 16-20 (Pls. XXXII. & XXXIII.), it extends far beyond the hind end of the genital ducts, accompanying the rectum in its course, and lying to the right side of the kidney at the hinder extremity of the visceral mass. In the section depicted in fig. 20, which passes through the rectal coil at the bottom of the hind end of the visceral mass, the hypobranchial gland on the right side of the rectum appears to form a pair with the kidney on the left, but there is, of course, no relationship between the two organs. Throughout its course the hypobranchial gland consists of an irregularly folded flattened sac, from which short glandular diverticula are given off in all directions. In its terminal part, as is shown in figs. 18-20, the gland appears to be differentiated into two portions: one lying nearer the cesophageal end of the stomach is lined by an epithelium loaded with fine dark granules; the other portion, lying nearer to the mantle-cavity, is lined by an epithelium of the character shown in Pl. XXXIX. fig. 56. It is made up of large glandular cells, oblong in outline, and filled with a highly refracting granular substance which, when the cells are ready to discharge their contents, is accumulated into oval pellets, as shown in the figure. Between the gland-cells are long and very attenuated interstitial cells, of which the outer ends are expanded and produced to form a cover over the outer ends of the gland-cells. The nuclei of the interstitial cells lie in their expanded outer ends. I could find no trace of cilia. In nearly every specimen examined the mantle-cavity was full of a sticky gelatinous mass secreted by the hypobranchial gland.

From what precedes it is evident that the Helicinidae are a very homogeneous group, so far as their anatomical characters are concerned, and that such differences as I have been able to detect are of very little assistance in classification, the resemblances and differences in one set of organs suggesting one class of affinities, those of another set of organs suggesting another class. Thus, taking the arrangement of the coils of the intestine as a criterion, we should place *Alcadia*, *Orobophana*, and *Paleohelicina* close together, with *Lucidella* related but somewhat apart: *Eutrochatella* would go with *Aphanoconia* to form a distinct group. But if we took the characters of the female gonaducts as a criterion we should get a different arrangement. *Eutrochatella* would stand nearest to *Alcadia*, with *Aphanoconia* more distantly related: *Paleohelicina* with *Orobophana* would form a distinct group.

The nervous system is so similar in all the species that it affords a very slight guide, but, as far as the cerebral ganglia give any clue, the genera would fall into an arrangement consistent with their geographical distribution; *Alcadia*, *Lucidella*, and *Eutrochatella* forming one group; *Paleohelicina*, *Orobophana*, and *Aphanoconia* another. Finally, the radular characters, which have attracted a considerable share of the attention of systematists and in my experience afford the most reliable and readily

recognizable marks of distinction between different species, give a totally different result. Taking these as a criterion, *Eutrochatella* stands well apart: the remaining genera show a sufficient amount of similarity to justify our placing them in a single group, in which *Palaohelicina* stands nearest to *Alcadia*; *Aphanoconia* is closely related to *Palaohelicina*; *Orobophana*, while showing relationship to the two last named, has distinctive characters which keep it somewhat apart; and *Lucidella*, while showing relationship to *Alcadia*, has undergone modifications which, in one feature at any rate, resemble those which distinguish *Orobophana* from *Palaohelicina*.

On the whole, the radular characters afford the safest clue to affinity, agreeing as they do with the conclusions founded on conchological characters and on geographical distribution.

In all the Helicinidæ, so far as is known, the radular formula may be represented as $\infty.1(3+1+3).1.\infty$. The Proserpinidæ have a somewhat different, and the Hydrocenidæ a very different, formula, but they need not be considered here.

As different authors use different names in describing the teeth of Neritoid gastropods, I must define my terms before proceeding further. Of the teeth included in brackets in the formula, I call the single tooth in the centre the *median*; the three teeth on either side of it the *admedians*. The large tooth on either side of the admedians I call the *lateral*, and the numerous teeth to the outside of these the *marginals*. In *Eutrochatella*, as Troschel has shown, the lateral teeth are relatively very large and of characteristic shape, being mushroom-shaped, with the top of the pileus hollowed out to form an articular cavity, into which fits the stalk of the lateral tooth of the row next in front of it. The edge of the pileus is entire. I have attempted in fig. 57 (Pl. XL.) to give some idea of the very complicated structure of this tooth in *Eutrochatella pulchella*. It should be noted that it has an external process, or "Basalanhang," which Troschel described as characteristic of the genus *Helicina*. For the rest, this mushroom-shaped tooth more nearly resembles in shape the corresponding radular tooth in the Neritidæ than is the case in any other Helicinid. The marginal teeth of *Eutrochatella* are simply pointed curved bars, without denticulations at their free extremities. In the genus *Helicina* Lamarck (*non sensu restricto* Wagner) the laterals are not pileiform, but consist of a stout median portion which I shall call the "stalk"; from the inner side of this a more or less broad aliform plate projects obliquely forward; the anterior border of this plate is thickened, recurved, and bears a number of denticulations, varying from 7 to 12 in number in the different species that I have studied. Attached to the outside of the stalk by an imperfect joint is the pointed external process (the "Basalanhang" of Troschel), and the top of the stalk is excavated to form an articular cavity for the hinder end of the stalk of the corresponding tooth in the row next preceding. Also, in all species of *Helicina* the marginal teeth have broadened recurved

anterior extremities bearing denticulations. Thus, there is a considerable difference between *Eutrochatella* and *Helicina*, but the gap is bridged over by *Trochatella chrysochasma*, in which, according to Troschel, the lateral tooth is pileiform, but with an oblique anterior border bearing from 7 to 9 denticulations, and whereas the proximal marginal teeth are simply pointed as in *Eutrochatella*, the more distal marginals bear denticulations, increasing from one to four in number. I have shown that anatomically *Eutrochatella* bears the closest resemblance to *Alcadia*, differing only in the arrangement of the coils of the intestine.

The genus *Alcadia* is characterized by a notch separating the peristome of the shell from the columella. It is stated (Fischer, 'Manuel de Conchyliologie,' p. 795) that the operculum has a dentiform process: I can only say that I cannot find a trace of any such structure in *A. palliata* and *A. hollandi*. In all other respects *Alcadia* is similar to the point of identity to *Helicina*. Troschel declares that the only recognizable difference between the radulæ of *Alcadia* and *Helicina* is in the form of the median tooth, a character of very little value, for, as I shall show, the shape of this tooth varies from species to species. But Troschel's figure of the radula of *Alcadia* is not very exact. I have given in Pl. XL. fig. 58, *a* to *f*, large scale drawings of the teeth of *A. hollandi*; those of *A. palliata* differ only in minute particulars. Comparing these with the drawings of the radulæ of *Lucidella*, *Palæohelicina*, *Orobophana*, and *Aphanoconia* (Pls. XL.-XLII. figs. 59-65), it will be seen that the first admedian tooth of *Alcadia* has a characteristic shape, being subquadrangular in outline, with its anterior outer angle produced into a knob on which are borne four blunt denticulations. The large lateral has a short stalk, hardly projecting behind the origin of the aliform plate: the latter is large, expanded, bearing seven stout but blunt teeth on its recurved anterior margin. The articular excavation is very shallow: the external process long and pointed.

Of the other radulæ figured, those of *Palæohelicina* (Pl. XLI. fig. 60) and *Aphanoconia* (Pls. XLI. & XLII. figs. 62-65) bear the closest resemblance to *Alcadia*. Both these genera were included in *Helicina* Lamarck, and have only recently been separated by Wagner. In them the lateral teeth have the same general shape as in *Alcadia*, but the stalk is longer, the aliform plate less expanded, the denticulations on its anterior border vary in size, shape, and number. The first admedian tooth is very similar in the two genera, and differs from that of *Alcadia*. The median tooth is very variable in size and shape. The similarity of the radulæ of *Palæohelicina* and *Aphanoconia* is remarkable, and leads one to doubt whether Wagner is justified in placing these forms in different genera. On the other hand, *Orobophana* (Pl. XLI. fig. 61) is distinct: its lateral tooth is that of *Palæohelicina*, but the first admedian is relatively large, acutely triangular, its anterior border thickened but without denticulations; it is feebly corneous and nearly transparent, suggesting that it is in

course of disappearance. The median tooth is heart-shaped, minute, and similarly feebly corneous. *Lucidella* (Pl. XL. fig. 59) is quite distinct in radular characters: in the lateral teeth the stalk is practically obsolete, the bulk of the tooth consisting mostly of the aliform process with its thickened denticulate border, which is continued posteriorly into the articular knob. There is no anterior articular excavation, but a thin triangular external piece which serves to support the articular knob of the tooth of the row next in front, and for the attachment of the external process. The third admedians are of the usual petaloid shape; the second admedians stout, triangular, with a thickened curved anterior edge, bearing on its outer surface a small minutely denticulate trenchant process. The first admedians are rather large, but feebly corneous, with a thickened anterior non-denticulate border; they have been modified in a manner analogous to what has been observed in *Orobophana*. The medians are broadly heart-shaped, feebly corneous, nearly divided into two by a deep median anterior notch.

Summing up these details and taking into comparison Troschel's figures, which are mostly of species of *Helicina* sensu restricto of Wagner, and confining our attention to the lateral tooth, which is the largest and obviously of most functional importance in the Neritacea as well as in the Helinacea, we see that there is an easy transition from *Eutrochatella* to *Alcadia*: that the lateral tooth of *Alcadia* is of the form characteristic of the Helicinidæ in general, but shows a tendency to a reduction of the stalk, which, as Troschel has shown, is common to many American and West-Indian species. This tendency is exhibited in an extreme form by *Lucidella*. But in the Pacific and Oriental genera the stalk and the articular excavation connected with it are well developed. But the lateral tooth of *Eutrochatella* bears an extremely close resemblance to that of the Neritidæ, and there is this further resemblance, that the first admedian tooth, which is of very large size in the Neritidæ, is relatively of much larger size as compared with the second and third admedians in *Eutrochatella* than in any other Helicinid. If such characters can be relied upon as a guide to affinity, *Eutrochatella* is the most closely related among the Helicinidæ to the Neritoid ancestor of the group. From *Eutrochatella* forms have been derived: on the one hand, the Proserpinidæ, which also have a large pileiform lateral tooth; on the other hand, *Helicina*. We may infer that the earliest *Helicina* retained the stalk and articular excavation which are such marked features in the pileiform lateral tooth of *Eutrochatella* and *Proserpina*.

The forms which, as suggested in the earlier part of this paper, were transported by some unknown means across the Pacific Ocean to the Philippines must have possessed these features and transmitted them unchanged to their descendants which now inhabit the Oriental and Indo-Pacific regions. But in America and the West Indies there has been a tendency, more

fully realised in some species than in others, to a reduction of the stalk and articular cavity, this reduction being shown to a slight degree in *Alcadia*, to a marked degree in *Lucidella*.

In all the Helicinidæ there is a tendency to the reduction of the central and admedian teeth: this tendency is shown in a marked degree in *Lucidella* and *Orobophana*, but must have reached its present degree independently in these two genera. The reduction is carried to an extreme degree in *Hydrocena*, in which the second and third admedians have disappeared; the median and first admedian are present, but in a rudimentary condition, and the laterals are reduced to mere rods of no great size. But I am disposed to think that the Hydrocenidæ must have branched off from the Neritoid stock independently of the Helicinidæ. They retain many primitive features, as Thiele has shown, among others the process of the operculum which is quite Neritoid in character, and their geographical distribution favours this view. *Hydrocena* is confined to the marine littoral of Dalmatia; *Georissa* lives at considerable altitudes on the Khasi Hills in India. It is by no means improbable that pulmonate forms may have been developed more than once from such animals as the Neritidæ, which show a predilection for migrating as far as possible out of the water, and for the rest of it, the most that can be said in favour of uniting the Hydrocenidæ with the Helicinidæ is that both display strong Neritoid affinities.

The main result of my researches is to show that in such a limited group as the Helicinidæ the systematists are justified in their methods. The visceral anatomy of all the forms that I have examined is strikingly similar, and where deviations occur they are contradictory and of uncertain value. The Helicinidæ appear to have inherited an organization with marked Neritoid characteristics, and to have maintained it, with little or no change. Presumably that organization is well adapted to the somewhat narrow range of the conditions of their existence, and any deviation from it has been checked by the action of natural selection. But there are a thousand deviations, in all directions, among characters which cannot by any stretch of the imagination be claimed to be of any importance in the struggle for existence. Such characters are the texture and coloration of the shell; the shape of the aperture; the extent and distinctness of the basal callus; the presence or absence of folds at the aperture of the shell; the presence or absence of a minute notch, such as occurs in *Alcadia*; the arrangement of the growth-lines on the operculum. It might be said that the operculum is an important protective organ and therefore eminently susceptible to the action of natural selection. But its function is simply to close the aperture of the shell, and this it does equally efficiently in all the species that I have examined, the number of these being much larger than the few available for anatomical study. As long as the operculum performs this function efficiently minute characters, such as the greater or less distance of its nucleus from

the anterior border, cannot possibly determine the question of the death or survival of the animal. The same reasoning applies to the variations of the radular teeth: the function of the radula is to rasp, and any of the modifications shown in figs. 60 to 65 is equally efficient as a rasp. Nobody, I think, would venture to assert that the minute differences in the four species of *Aphanoconia* (figs. 62 to 65) could have had any value in the differentiation of these species by natural selection.

As a result of my somewhat elaborately minute studies, I am driven, and, I confess, somewhat unwillingly driven, to the conclusion arrived at by a number of naturalists, that natural selection is efficient in preserving characters of physiological importance, but ineffective in producing new species by adding together numerous minute successive variations. The only conclusion justified by the facts seems to me to be that the characters on which systematists rightly rely are of the nature of deviations or mutations, of no consequence to the well-being of the animals in which they appear, but inheritable, and therefore perpetuated under favourable circumstances by segregate breeding. The Helicinidæ, inhabiting narrow areas, and often segregated in remote islands, afford particularly favourable opportunities for segregate breeding.

As to how far these small deviations of functionally unimportant structures may be due to the influence of external conditions I do not venture to offer an opinion, but the following fact is suggestive. Among the shells in the tube containing several specimens of *Aphanoconia merguensis* was a specimen which in size, shape, coloration, and marking so exactly resembled the others that I took it for a Helicinid (as the collector must also have taken it) and decalcified it with a view to anatomical investigation. It proved to be a Helicid, of what genus and species I cannot say, as I had destroyed the shell and could not find another specimen.

Among the collection of Helicinidæ made in the Andaman Islands and presented to the British Museum of Natural History by Mr. G. Rogers was a tube containing half a dozen specimens which differ recognizably in the characters of the shell and operculum from *Aphanoconia andamanica* Benson, but are clearly closely related to that species. I have not been able to refer them to any named species, and as the radular characters show it to be distinct from *andamanica*, I describe it as a new species, as follows:—

APHANOCONIA ROGERSII, sp. n. (Pl. XLII. figs. 65–69.)

Shell oblately spheroidal, the surface marked with closely set radial growth-lines; colour light orange-yellow marked with more or less distinct reddish-brown radial bands; spire of $4\frac{1}{4}$ whorls, increasing regularly and somewhat rapidly in size, the last whorl obtusely keeled, the keel produced into a prominent angular

projection at the peristome. Aperture semilunar, very oblique, the outer margin thickened and expanded. Basal callus not very thick, hardly differing in colour from the rest of the shell, of rather small extent, its limits clearly defined above, as well as below. The whole shell deeper in proportion to its breadth than in *A. audamanica* and the spire more prominent.

Operculum yellowish white in colour, the calcareous plate rather thin, the sigmoid curve pronounced, the upper angle produced.

Radula with small diamond-shaped median tooth; the first admedian tooth more than twice as long as broad, the anterior edge incurved and bearing four denticulations; second and third admedian teeth each with four denticulations; the lateral teeth normal, the stalk rather long, the articular excavation deep, the aliform process bearing seven round denticulations.

Closely as the shell of this species resembles that of *A. audamanica*, a glance at the drawings of the radulae of the two species (figs. 63 & 65) shows that they are distinct.

I must express my obligations to Miss Margaret Poole, both for helping me in the determination of the different species of *Aphanoconia* and for making the drawings of shells and radulae for figs. 62 to 68.

As I have discussed and offered an explanation of the geographical distribution of the Helicinidae without either adopting or criticizing the theories advanced by Dr. Simroth (7 and 8) on this subject, I must, in conclusion, make some reply to the friendly criticisms that he has published on my paper on the Neritidae. I do not propose, in this place, to discuss the physiological interpretation that he has given of the different arrangements of the female ducts in the Neritidae. For one thing, I have obtained some new material and hope soon to publish further observations throwing fresh light upon the problems to which he refers: for another, I am inclined to accept much of what he writes on that part of the subject.

But with regard to the ancestry of the Neritidae, and with them the Helicinidae, which Dr. Simroth would derive from a pulmonate stock, and with regard to the homologies that he wishes to establish between the generative ducts of Neritidae and Pulmonata, I am unable to accept any of his conclusions. To do so would be to throw the whole fabric of morphological reasoning to the ground. Dr. Simroth's views on homologies are largely influenced by a theory of secular changes in the sea-level produced by a swinging or "pendulating" movement of the earth about an axis which corresponds with the longest diameter of the earth and has its poles in Sumatra and Ecuador. It is not my present intention to discuss the difficult astronomical and geological problems involved in the "Pendulation theory," and, indeed, I am sure that I am incompetent to discuss them. The theory may be well founded or it may not: I do not offer an opinion; but be it right or

wrong, I fail to see that the conclusions deduced from it by Dr. Simroth are necessary. I will explain as briefly as possible why. Unless I misunderstand him grievously, and if I do I beg his pardon, one of Dr. Simroth's chief conclusions is that, contrary to the generally accepted doctrine, marine and freshwater animals in general, the marine prosobranch Gastropods in particular, are evolved from terrestrial forms which have been forced by the above-mentioned secular inundations to adapt themselves to new conditions of life and make their habitat in another medium. As the pendulation theory applies to all geological time, if the precursors of marine Gastropods were terrestrial in habit, we should find evidence of this in geological deposits. The earliest-known Gastropods, from the Cambrian to the Devonian, would bear evidence of their terrestrial life, those found in later deposits would indicate, in some periods at least, the change from a terrestrial to a marine existence. But, in point of fact, the geological evidence points decisively the other way. In Cambrian, Ordovician, Silurian, and Devonian deposits we get Gastropods belonging almost exclusively to the Streptoneurous Aspidobranchia and Pectinibranchia. There are, it is true, the pteropod-like shells of the Conularida which, if they are really remains of Pteropods, would demonstrate the great antiquity of highly specialized forms of Euthyneura. But the true systematic position of the Cornularida is at the best doubtful, and it has been urged with much reason and on high authority that the resemblance between the shells of these archaic forms and the more modern Pteropoda is due to parallelism. As so much doubt prevails as to their affinities, the Cornularida cannot be brought into the argument. The Aspidobranchiate and Pectinibranchiate Gastropods from these earlier Palæozoic deposits are without doubt marine forms. They subsisted, without any important changes, through the four above-mentioned geological epochs, and one genus, *Pleurotomaria*, has survived to the present day. We know the habits and the anatomy of *Pleurotomaria*, and they support in a most remarkable manner the conclusions derived from an extensive knowledge of gastropod morphology. On the other hand, with the exception of *Hercynella* from the Devonian, undoubted Euthyneura first make their appearance in the Carboniferous. They belong to the Actæonidæ and Pulmonata Stylommatophora. The first-named family is marine, and anatomically displays so many streptoneurous characters that it might almost be included in the Aspidobranchia. Of the Stylommatophora we get forms like *Dendropupa* and *Pyramidula*, unquestionably terrestrial species, and, according to views generally accepted, highly modified and therefore indicative of a line of lost ancestry probably allied to the contemporary Actæonidæ. But these pulmonate forms are few and of rare occurrence in the Carboniferous, a period in which the conditions for the preservation of terrestrial and freshwater forms were particularly favourable. Had numerous Pulmonates existed at that time their remains must have been more abundantly

preserved. Terrestrial pulmonates are still scanty in the Permian and Trias, and only begin to show a considerable increase in the Jurassic and Cretaceous. I need not labour the point further. Clearly, paleontological evidence does not favour Dr. Simroth's theory of the origin of marine from terrestrial Gastropoda.

But let us suppose that paleontological evidence may be ignored on account of the imperfection of the geological record, and that the Pendulation theory is so well supported by other evidence as to compel us to give credence to Dr. Simroth's doctrines as to the origin of marine from terrestrial Gastropods. The Helicinidae are terrestrial and pulmonate. I have shown, and in so doing have only corroborated the opinion of all other observers, that they are Neritoid in almost every feature of their anatomy. If the marine and fluviatile Neritids were to be derived from a terrestrial and pulmonate form, one would suppose that that form must have been Helicinid in character, for the affinities between the two groups are so very obvious. But Dr. Simroth does not discuss this possibility. Making reference to *Ostracolethe*, *Hyalimax*, *Limax*, and *Arion*, all highly specialized recent Pulmonates, he boldly derives the Neritidae from the Stylommatophora, relying largely upon the supposed homology of their generative ducts. This homology I do not admit: a resemblance there is, but not a close one, and, even if it were closer than it actually is, I should place very little reliance on the anatomy of the generative ducts as indicative of relationship between groups differing widely in all other respects. In the different phyla of invertebrated animals the generative ducts are notoriously variable in character. In the Platyhelminia, for example, their variety is bewildering. Within the phylum Mollusca there are many instances of variability and also of deviations which must have been independently acquired but are in the same direction, as, for instance, in the Doridomorpha and Elysioromorpha. The resemblances, such as they are, between the generative ducts of the monœcious Pulmonata and the dicecious Neritidae are just what one might expect to find in animals in which a common plan of organization, to wit a gastropod organization, is modified in accordance with similar physiological requirements. The differences are of amply sufficient magnitude to betray a difference of origin. In other words, the complex gonaducts of Neritidae and Pulmonata are independently acquired structures, and such resemblances as they display are due to parallelism.

I have already referred to the anatomy of the Pleurotomariidae, a family which existed in the Cambrian and survives to the present day. Thanks to Bouvier and M. F. Woodward, we are well acquainted with the anatomy of *Pleurotomaria*, which affords a striking confirmation of the reliability of sound morphological reasoning. Before *Pleurotomaria* had been studied, comparative anatomists, as the result of extensive investigations of gastropod structure, had come to an agreement concerning numerous marks of primitive organization in the group. When this survivor from

the Palæozoic age came to be examined, all these marks were found, some of them in a more pronounced degree than in any other known Gastropod, and in no system of organs were these marks more conspicuous than in the nervous system, the importance of which Dr. Simroth seeks to minimize. Among these marks may be enumerated—a cerebral commissure situated far forward on the pharyngeal bulb; a distinct labial commissure; elongated and scalariform pedal nerve-centres; a long crossed visceral commissure; two auricles to the heart; the ventricle lapped round the rectum; a rhipidoglossate dentition. Other characters might be enumerated, but these suffice for the present purpose. All these characters are absent in the Pulmonata: all of them are present in the Neritidæ. Moreover, by discovering the oviduco-cœlomic funnel, I was able to demonstrate, beyond all reasonable doubt, the homology of a part of the gonaducts to the right kidney of *Pleurotomaria* and other rhipidoglossate Aspidobranchs, a homology which Thiele had already asserted on other grounds. Now it is quite clear that, if structural resemblance is of any value as a guide to affinity, we have a choice between two alternatives. Either the Neritidæ, to which we must add the Helicinidæ, are descended from Aspidobranch ancestors, which they resemble in all the points enumerated above, and have independently acquired genital ducts superficially similar to those of Pulmonata; or, as Dr. Simroth will have it, they have descended from stylommatophorous Pulmonata, have preserved the characters of the genital ducts of the latter group, but have independently acquired all the other characters enumerated above, characters possessed by no Pulmonate, but invariably present in those Aspidobranchs from which, on Dr. Simroth's showing, the Neritidæ are not descended. I am not quite sure whether he would go so far as to assert that the remaining Aspidobranchs possess those characters because they are descended from the Neritidæ. To make such an assertion would, indeed, be flying in the face of all reasoned opinion on this subject, and would amount to a declaration that the geologically more recent Pulmonates are the parents of their predecessors of Cambrian age!

I submit the alternative to the judgment of my readers, and in doing so beg leave to enter a protest against the growing tendency to throw over long-established and carefully reasoned conclusions founded upon morphological evidence, because of their unconformity with some new and as yet insufficiently tested hypothesis, or because they do not help in the solution of certain limited problems. I was quite aware, when I discussed the subject, that the geographical distribution of the Neritidæ was a puzzle, and that I had failed to find a solution to it. The distribution of the Helicinidæ is scarcely less puzzling and awaits a final solution. But with all respect for Dr. Simroth's authority and deserved reputation as a zoologist, I submit that the solution that he offers is improbable, raises a crop of other puzzles, and throws morphology into confusion.

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(A complete list of the literature of the Neritoidea is given in my previous paper [2]).

EXPLANATION OF THE PLATES.

PLATES XXX.–XLII.

Lettering in all the figures.

<i>an.</i> Anus.	<i>con. ped.</i> Cerebro-pedal connective.
<i>ao.</i> Aorta.	<i>con. pl.</i> Cerebro-pleural connective.
<i>ap. mg.</i> Aperture of hypobranchial gland.	<i>c. ph.</i> Lateral pharyngeal cartilage.
<i>Au.</i> Auricle.	<i>div.</i> Diverticulum of male gonaduct.
<i>buc.</i> Buccal cavity.	<i>E.</i> Eye.
<i>cæ.</i> Cæcum of ootype.	<i>F.</i> Foot.
<i>cl.</i> Cloaca.	<i>g. bucc.</i> Buccal ganglion.
<i>c. m. l.</i> Left columellar muscle.	<i>g. cer.</i> Cerebral ganglion.
<i>c. m. r.</i> Right columellar muscle.	<i>Gd.</i> Gonaduct.
<i>com. bucc.</i> Buccal commissure.	<i>gl. pd.</i> Pedal gland.
<i>com. cer.</i> Cerebral commissure.	<i>gl. r.</i> Glandular ridge on floor of the œsophagus.
<i>com. lab.</i> Labial commissure.	<i>g. pl.</i> Pleural ganglion.
<i>com. pd.</i> Pedal commissure.	<i>Int.</i> Intestine.
<i>com. pl.</i> Pleural commissure.	

<i>Li.</i> Liver.	<i>oot.</i> Ootype.
<i>li. d.</i> Liver-ducts.	<i>Op.</i> Operculum.
<i>M.</i> Mantle.	<i>ot.</i> Otocyst.
<i>M. c.</i> Mantle-cavity.	<i>ov.</i> Ovary.
<i>m. g.</i> Hypobranchial gland.	<i>Pc.</i> Pericardium.
<i>n. cm. l.</i> Left columellar nerve.	<i>ped.</i> Pedal nerve-cords.
<i>n. cm. r.</i> Right columellar nerve.	<i>ph.</i> Pharynx.
<i>n. gen.</i> Genital nerve.	<i>R.</i> Rectum.
<i>n. gl. p.</i> Nerve to pedal gland.	<i>rd.</i> Radula.
<i>n. lpb.</i> Labio-proboscidian nerves.	<i>rd. s.</i> Radular sac.
<i>n. oc.</i> Ocular nerve.	<i>r. p.c.</i> Reno-pericardial canal.
<i>n. op. l.</i> Left opercular nerve.	<i>r. s.</i> Receptaculum seminis.
<i>n. op. r.</i> Right opercular nerve.	<i>s. gl.</i> Salivary gland.
<i>n. ot.</i> Otocyst nerve.	<i>Sn.</i> Snout.
<i>n. pal.-c.l.</i> Left pallio-columellar nerve.	<i>sp. d.</i> Sperm-duct.
<i>n. pal.-c.r.</i> Right pallio-columellar nerve.	<i>spz.</i> Spermatozoa.
<i>n. pal.l.</i> Left pallial nerve.	<i>St.</i> Œsophageal moiety of stomach.
<i>n. pal.r.</i> Right pallial nerve.	<i>St¹.</i> Pyloric moiety of stomach.
<i>n. par.l.</i> Left parietal nerve.	<i>t.</i> Tentacle.
<i>n. par.r.</i> Right parietal nerve.	<i>t. s.</i> Terminal sac of male gonaduct.
<i>n. sb.i.</i> Subintestinal nerve.	<i>Ur.</i> Ureter.
<i>n. ten.</i> Tentacular nerve.	<i>Ur.p.</i> Uropore.
<i>od.</i> Oviduct.	<i>V.</i> Ventricle of heart.
<i>od¹.</i> Descending limb of V-shaped portion of oviduct.	<i>vag.</i> Vagina.
<i>od².</i> Ascending limb of V-shaped portion of oviduct.	<i>vag. ap.</i> Opening of vagina into mantle-cavity.
<i>od. c. a.</i> Anterior odontophoral cartilage.	<i>vg. s.</i> Vaginal sac.
<i>od. c. p.</i> Posterior odontophoral cartilage.	<i>V.G¹.</i> First visceral ganglion.
<i>œ.</i> Œsophagus.	<i>V.G².</i> Second visceral ganglion.
<i>œ. p.</i> Œsophageal pouch.	<i>v. pal.</i> Pallial vein.
<i>o. œ. p.</i> Opening of Œsophageal pouch into Œsophagus.	<i>v. pst.</i> Posterior pallial vein.
	<i>v. ren.</i> Afferent renal vein.

- Fig. 1. Left side view of *Alcadia palliata*. The mantle has been cut through close to the left columellar muscle and turned back to expose the interior of the mantle-cavity, the pericardium has also been opened.
- Fig. 2. Dorsal view of the buccal cavity, pharynx, and anterior part of the Œsophagus of *Alcadia palliata*: the buccal cavity, pharynx, and part of the Œsophagus have been laid open; *gl.r.*, glandular ridge on the floor of the Œsophagus.
- Fig. 3. A dissection of the Œsophagus and pharynx of *Alcadia palliata*, seen from the left side.
- Fig. 4. A horizontal section through the pharynx and buccal cavity of *Alcadia hollandi*.
- Fig. 5. The odontophoral cartilages of *Alcadia palliata*, viewed from below.
- Fig. 6. The odontophoral cartilages of *Eutrochatella pulchella*, viewed from above.
- Fig. 7. A dissection of the stomach of *Alcadia palliata*, viewed from the ventral side.
- Fig. 8. A portion of the epithelium of the stomach of *Alcadia hollandi*, showing glandular and ciliated cells. \times about 960.
- Fig. 9. Part of a section through the prominent ridge in the stomach of *Alcadia hollandi*, \times about 600; *cu.*, the thick cuticle covering the ridge.
- Fig. 10. The alimentary tract of *Alcadia palliata*, showing the arrangement of the intestinal coils.
- Fig. 11. Alimentary tract of *Alcadia hollandi*.
- Fig. 12. Alimentary tract of *Palæohelicina idæ*.
- Fig. 13. Alimentary tract of *Orobophana ponsonbyi*.
- Fig. 14. Alimentary tract of *Lucidella aureola*.
- Fig. 15. Alimentary tract of *Eutrochatella pulchella*.
- Fig. 16. A horizontal section through the upper part of the visceral mass of *Alcadia hollandi*. Figs. 17 to 22 are drawn from the same series of sections.
- Fig. 17. A section somewhat lower down, showing the origin of the ureter, *Ur.*, from the kidney.

- Fig. 18. A section still more ventral than the above, showing the deepest part of the pericardium and its relation to the kidney.
- Fig. 19. A more ventral section passing through the reno-pericardial canal, *r.p.c.*
- Fig. 20. A similar section passing through the ventral part of the visceral mass.
- Fig. 21. Part of a section slightly ventral to that drawn in fig. 19, showing the uropore, *Ur.p.*, opening into the mantle-cavity.
- Fig. 22. A section through the reno-pericardial canal. Magnified about 600.
- Fig. 23. Part of a section passing through the uropore of *Lucidella aureola* and showing the character of the renal epithelium. $\times 960$.
- Fig. 24. A diagram reconstructed from the series of sections drawn in figs. 16 to 20, showing the relations of the kidney, ureter, stomach, pericardium, and mantle-cavity.
- Fig. 25. The genital ducts of *Alcadia hollandi* ♀. The lower half of the figure is drawn as it appears when viewed by transmitted light, the upper part as seen by reflected light. In this and in figs. 26-29, 40, and 41, the gonaducts are represented as seen from the ventral side, after the wall of the mantle-cavity has been cut through by a dorsal incision and the rectum and gonaducts turned over to the right side of the animal.
- Fig. 26. The genital ducts of *Eutrochatella pulchella* ♀.
- Fig. 27. The genital ducts of *Aphanoconia merguensis* ♀.
- Fig. 28. The genital ducts of *Palæohelicina idæ* ♀.
- Fig. 29. The genital ducts of *Orobophana ponsonbyi* ♀.
- Fig. 30. A longitudinal section through the genital ducts of *Alcadia hollandi* ♀, passing through the aperture of the hypobranchial gland.
- Fig. 31. A longitudinal section from the same series, showing the aperture of the vaginal duct.
- Fig. 32. Another section from the same series, showing the origin of the oviduct from the ovarian chamber.
- Fig. 33. Another section from the same series showing the connection of the vagina with the vaginal sac and ootype.
- Fig. 34. Another section from the same series showing the opening of the oviduct, *od.*, into the descending limb of the V-shaped tube, *od.*
- Fig. 35. Another section from the same series showing the receptaculum seminis opening into the ascending limb of the V-shaped tube.
- Fig. 36. Glandular epithelium from the wall of the ootype of *Alcadia hollandi*.
- Fig. 37. Ciliated epithelium and spermatozoa from the receptaculum seminis of *Alcadia hollandi*.
- Fig. 38. A section through the oviduct of *Alcadia hollandi*. Highly magnified.
- Fig. 39. An epithelial ridge from the bilobed cæcum of the ootype of *Orobophana ponsonbyi*.
- Fig. 40. A view of the genital ducts of *Alcadia hollandi* ♂.
- Fig. 41. A similar view of the genital ducts of *Aphanoconia gouldiana* ♂.
- Fig. 42. A drawing made from a combination of several serial longitudinal sections through the genital ducts of *Eutrochatella pulchella* ♂, showing the narrow diverticulum, *k.r.*, which may possibly represent the vagina of the female and therefore be the homologue of the right kidney-sac.
- Fig. 43. A dissection showing the pedal, pleural, and visceral nerve-centres in *Alcadia palliata*, with the principal nerves issuing from them. The cerebral ganglia have been removed. The dissection is made from the dorsal surface; the foot, as is usual in contracted specimens, is turned forward and lies in front of the head with the sole uppermost; the walls of the head and the mantle have been cut away, and the visceral mass has been dissected as far as is necessary to show the course of the subintestinal nerve and its branches.
- Fig. 44. The nerve-centres and principal nerve-trunks of *Alcadia hollandi*, viewed from the right and above. The drawing was made with the camera lucida, after removal of the nerve-centres from the body.
- Figs. 45-52. A series of transverse sections through the pleuro-pedal nerve-centres of *Alcadia hollandi*, showing the principal tracts of nerve-fibres in the fused pedal, pleural, and subintestinal ganglia. For a full description of these figures, see the text, p. 789. The position of the pedal gland is indicated in fig. 45.
- Fig. 53. The left cerebral ganglion of *Palæohelicina idæ*, viewed from the inner surface. The ganglion is stained with Mayer's hæmalum and drawn by transmitted light; 1, 2, 3, 4, the four labio-proboscidæan nerves.
- Fig. 54. A similar preparation of the left cerebral ganglion of *Alcadia palliata*.

- Fig. 55. A drawing of a section showing the position, structure, and nerve-supply of the opercular organ of *Eutrochatella pulchella*.
- Fig. 56. A portion of the epithelium of the hypobranchial gland of *Alcadia hollandi*. Highly magnified.
- Fig. 57. A left lateral tooth from the radula of *Eutrochatella pulchella*. Highly magnified.
- Fig. 58. Radular teeth of *Alcadia hollandi*, highly magnified; *a*, median; *b*, *c*, *d*, first, second, and third admedians of the left side; *f*, one of the marginals or uncini; *e*, a lateral tooth of the right side showing the stalk, *stk.*, the aliform internal plate, *al.p.*, the articular excavation, *art.*, and the process, *ext.p.*
- Fig. 59. Three rows of teeth from the radula of *Lucidella aureola*. In this and the following figures only the proximal members of the marginals are indicated.
- Fig. 60. Two rows of teeth from the radula of *Palæohelicina idæ*.
- Fig. 61. Two rows of teeth from the radula of *Orobophana pachystoma ponsonbyi*.
- Fig. 62. Two rows of teeth from the radula of *Aphanoconia gouldiana*.
- Fig. 63. Two rows of teeth from the radula of *Aphanoconia andamanica*.
- Fig. 64. Two rows of teeth from the radula of *Aphanoconia merguensis*.
- Fig. 65. Two rows of teeth from the radula of *Aphanoconia rogersii*.
- Fig. 66. Shell of *Aphanoconia rogersii*.
- Fig. 67. Shell of the same species, showing the aperture.
- Fig. 68. Shell of the same species, viewed from above.
- Fig. 69. Operculum of *Aphanoconia rogersii*, viewed from the inner or ventral side.

36. On the Palatability of some British Insects, with Notes on the Significance of Mimetic Resemblances. By R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Society's Gardens and Curator of Mammals. With Notes upon the Experiments. By Prof. E. B. POULTON, F.R.S., F.Z.S.

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INTRODUCTION.

At the request of Prof. E. B. Poulton, F.R.S., I undertook, in the summer of 1909 and again in that of 1910*, to make a series of experiments in the Zoological Gardens to test the palatability of various species of British Insects. Much of the material was sent to me by Dr. G. B. Longstaff from Morthoe in Devonshire. Some I received from Prof. Poulton himself or from friends of his. A few species I added on my own account; notably the stick insects and the ants, of which we had an abundant supply in the Insect House in the Gardens. Those that I supplied I identified myself. The rest were in all cases named by the senders. To the insects Dr. Longstaff added a number of slugs, which were identified, I understand, by Mrs. Longstaff.

Since the majority of the experiments were made with English Insects, it is regrettable that English, or at all events Palearctic birds, were, for the most part, unavailable for the tests. There were two reasons for this. In the first place, Palearctic insectivorous birds were not strongly represented in the Society's

* Records of a few experiments made in 1911 have been incorporated in the text.

collection. In the second place, those that were in the Zoological Gardens at the time were, in most cases, kept in a very large flight aviary with plenty of cover in the way of shrubs, representing their natural environment as nearly as possible. Never having been tamed by confinement in small cages, they were too shy to come to the bars to take insects from my hand and too scared to notice them if I entered the aviary. Once or twice I tried the experiment of liberating butterflies in this aviary; but the frequency with which they escaped through the wire mesh and were wasted for the purpose in hand, induced me to abandon further experiments of that kind.

This reference to the shyness of birds in captivity brings me to another of the limitations under which I was working. I was forced to restrict my attention to particular birds, tame enough either to take insects directly from me or sufficiently accustomed to the presence of human beings in the aviary to capture liberated insects in spite of my close proximity. If I put the insects through the bars, myself standing outside, they were either seized one after another by the boldest bird in the place, or were carried by a timid bird to the back of the compartment, where I could not watch what befell them. I was compelled, therefore, to be inside the bars. Since, moreover, it was practically impossible to watch more than one bird at a time, I was precluded from the method of experimenting with the shyer specimens by giving insects to the bolder ones to distract and monopolize their attention. Thus it comes about that the same species appear over and over again in the experiments below recorded, while many insectivorous birds, that might have been tried but for their shyness, are omitted.

Two facts struck me very forcibly at an early stage of the experiments. The first was the exceeding keenness of the birds for the insects brought to them. This was no doubt due in a measure to our inability in the Gardens to feed the birds on living insects other than mealworms. The living prey was evidently a great treat to them; and over and over again I was impressed with the persistence shown by birds in persevering with insects that were obviously not to their liking, returning to the morsels repeatedly as if food of such a nature was too good to be wasted. From this I think it may be inferred that in a state of nature hungry birds will eat nauseous insects which in times of plenty they will reject after tasting, or will not take the trouble to catch them if they have previously learnt their distastefulness by experience. Furthermore, it is quite clear that the plain record of an insect being eaten is no proof of its palatability. Better evidence on this head is supplied by the behaviour of the bird towards it. After a little experience in this matter, I was able to satisfy myself at all events as to the approximate correctness of my interpretation of the bird's actions, and to judge thereby of the comparative palatability of the insects they tasted.

The second fact has an important bearing upon the criticism sometimes advanced against the theory of warning coloration and mimicry as applied to butterflies, namely, that birds under natural conditions are seldom seen to eat these insects.* Hence it has been inferred that birds cannot be reckoned as serious enemies of butterflies. Whatever may be the explanation of the circumstance, I am tolerably sure, from the behaviour of the two classes of animals when pitted against one another, that the inference drawn therefrom is erroneous. The insectivorous birds in our aviaries seemed to know at once what the butterflies were; they were on the alert the moment one was liberated and pursued it with determination and precision, following its every turn and twist, and either catching it upon the wing or pouncing upon it after settling. It is true that this predatory deftness may have been acquired in relation to the chase of insects other than Lepidoptera; but unless the birds recognised butterflies in general—a group which cannot be mistaken for other insects—as part of their natural prey, it is difficult to understand their eager excitement at the sight of those I offered them.

Again, unless the species of butterflies used for the experiments are, or were in the past, habitually preyed upon by birds, whence comes the extraordinary skill the liberated specimens, when undamaged or inexhausted by confinement, displayed in dodging the swoop of the birds in mid-air? Having repeatedly seen the aim of the pursuing bird baffled by the evasive twist of the butterfly, I cannot doubt that the insect's behaviour was prompted by the instinct to escape an habitual enemy of its species, of the same class and with the same predatory methods. It cannot, I imagine, be seriously claimed that escape from the upleap of insectivorous mammals, lizards, or frogs has been a factor of sufficient importance in survival to be reckoned with in this connection; and, *a fortiori*, the modernness of the invention of the entomologist's net puts this instrument of capture out of court for consideration. The evidence, therefore, seems to me to afford the strongest support to the conclusion that the power to dodge in mid-air and the instinct to put it in force have been fostered to subserve no other purpose than the evasion of swift-winged insectivorous foes. Perhaps predatory Pompilidæ must be regarded as a possible auxiliary influence; but apart from these hymenoptera, I can think of no enemies but birds likely to have persecuted butterflies on the wing to the extent presumably necessary to have guided their evasive tactics to the pitch of proficiency they now exhibit.

Whatever be the value of this suggested explanation of the facts, the facts themselves remain as I have stated them:—(1) Caged insectivorous birds which, so far as is known, have never been fed in captivity upon butterflies, are at once excited by

* Twice I have seen sparrows, which are not typically insectivorous, chase white butterflies in London. Two birds acting in concert were successful on the first occasion; one single-handed failed on the second occasion.

their appearance, chase them with eager speed, catch them in mid-air with precision, and eat them or taste them with avidity. (2) Pursued butterflies when overtaken often avoid the birds, not once only but twice or three times, by sudden turns up or down to right or left.

Those who hold, on the negative evidence above stated, that birds are not to be reckoned as serious enemies of butterflies, must be called upon to supply some explanation other than that above proposed of the marked reactions between these two classes of animals when brought into contact with one another, and to show reason why what takes place in the aviary may not be regarded as indicative of similar occurrences in nature.

With regard to the experiments on mimicry, especially those made with *Volucella bombylans* and *Bombus hortorum*, it appears to me that they satisfy all that the theory, as propounded by Bates, demands. They fully confirm Prof. Lloyd Morgan's experiments on birds, with the drone-fly (*Eristalis*) and the honey-bee (*Apis mellifica*), as well as those with the banded and uncoloured slips of glass holding respectively meal adulterated with quinine and meal untampered with.* They show that several species of birds, after learning by experimental tasting that *Bombus hortorum* is unpalatable, refused to touch *Volucella bombylans*.

Other items of interest that may be briefly alluded to are the experiment demonstrating, at least in the instance tried, the attractive nature of the ocelli on the wings of the peacock butterfly (*Vanessa io*); the experiments showing that *Formica rufa* is not protected from mammals and birds by its acid taste; that the black members of the Carabidæ and *Ocypus olens* are unpalatable to the ground-feeding mammals they were offered to; that *Coccinella 7-punctata* and the Telephorid beetle (? *Rhagonyche fulva*)—belonging to families of beetles which are common objects of mimicry in the tropics—are distasteful to nearly all mammals and birds.

At the end of the part of the paper describing the experiments made, I have added, at Dr. Longstaff's suggestion, for the information of those unfamiliar with the habits and distribution of the mammals, birds, and reptiles to which the insects and other invertebrates were offered, a list of the species of the former groups giving a few particulars on those points.

Finally I have to thank Prof. Poulton for kindly annotating the paper before it went to press, and for explaining more fully than I could do the bearing of some of the results on the theories of mimicry and of the connection between palatability and coloration. I am also indebted to Commander J. J. Walker, R.N., for kindly giving me the scientific names of the Lepidoptera.

* Animal Behaviour, pp. 164-165, 1900.

THE EXPERIMENTS

MOLLUSCA.

(SLUGS.)

Large Black Slug (*Arion ater*).

Sept. 24, 1910. Two taken and eagerly eaten by two Meerkats, who wiped them down with their paws and rubbed them in the sand apparently to remove the slime.

Oct. 26, 1909. One given to Black-winged Grackle was eaten.

One (larger specimen) given to the same bird was abandoned; offered to Sulphury Tyrant, but the bird would not touch it; offered to Sun-Bittern, was pecked, but not eaten; carried to a perch by Harmonious Shrike-Thrush but was soon dropped; pecked and shaken about, and much hammered by Abbot's Rail, which managed to break the skin of the slug and getting at the inside ate a large portion, but would not eat the outside.

One taken by Dial Bird which persevered for a long time, hammering and wiping it in the sand; he was then driven off by Black-chinned Laughing Thrush, which held the slug in his foot and ate little pieces of the inside after breaking the skin, but left the bulk of it.

Dial Bird tried another, but gave it up.

Common Hangnest took one, but left it after a few pecks.

Two offered to Kagu, a kind of Crane or large Rail, were swallowed entire with very little delay.

One tried by Black-tailed Water-hen which, however, gave it up; the same specimen given to Leach's Laughing Kingfisher was ultimately swallowed entire after being dropped many times.

Arion hortensis.

(Olive-brown Slug with orange-coloured foot.)

Oct. 26, 1909. One eaten by Yellow crowned Hangnest.

Two eaten by Dial Bird.

Two refused by Harmonious Shrike-Thrush.

One twice taken from my hand by Harmonious Shrike-Thrush and dropped both times; but after taking it the third time the bird ate it.

Limax maximus.

Oct. 26, 1909. One given to Harmonious Shrike-Thrush was tried, but abandoned after one or two pecks. It was then taken and eaten by a Black-winged Grackle after a great deal of wiping of the bill.

Sept. 24, 1910. Two specimens tasted by Green Lizard, and Black-spotted Lizard, but not eaten. The Lizards apparently disliked the slime, because they wiped their mouths on the stones after tasting. Both eaten without delay by Glass Snake.

Limax agrestis.

Sept. 24, 1910. One eaten after a good deal of pecking about in the sand by White-crested Jay-Thrush.

Two eaten by a Shama.

One eaten by Kagu.

Tasted but rejected by Fantailed Flycatcher.

Tasted on two occasions by Hoopoe but rejected.

Tasted by Red-vented Bulbul but rejected.

Tasted but rejected by Yellow Hangnest.

Two taken, but not eaten, by Harmonious Shrike-Thrush.

Two taken, but not eaten, by Cuban Mocking Bird.

Limax arborum.

Sept. 24, 1910. Four eagerly eaten by Wall Lizards, which wiped their mouths to remove the slime after swallowing them.

Milax sowerbyi.

Sept. 24, 1910. One taken and pecked and wiped about in the sand for a long time by Indian Dial Bird, which finally left it.

Another specimen was eagerly taken by Sulphury Tyrant, which after pecking and crunching it in his beak, and banging it from side to side against a ledge, exactly as Laughing and other Kingfishers do, finally swallowed it whole.

ARACHNIDA.

OPILIONES (Long-legged Spiders or Harvestmen).

Phalangium sp.?

Sept. 1910. One (immature) tasted but immediately rejected by Pekin Robin; the same specimen then taken and eaten by hen Scarlet Tanager.

One (immature) put into cage with several Curassows was tasted in turn by specimens of Yarrell's and the Globose, and ultimately eaten by one of the Globose Curassows, when crushed beyond all recognition.

I was led to suppose these Arachnida would prove on experiment to be unpalatable owing to their possessing a pair of glands, one on each side of the dorsal area of the carapace, which are known to secrete an odorous fluid. As elsewhere recorded*, I have seen a Mason Wasp, hunting Spiders, run down a specimen of *Phalangium*, but turn aside and let it go unhurt the moment he touched it with his antennæ. More experiments with birds and lizards are required fully to substantiate my belief; but the refusal of the Pekin Robin to eat the *Phalangium* is very significant, and it is quite evident that the Arachnid was not to the liking of the Curassows.

* Journ. Linn. Soc., Zool. xxx. p. 268, 1909.

INSECTA.

Order LEPIDOPTERA.

Butterflies.

Group PIERINÆ.

THE SMALL WHITE (*Pieris rapæ*).

July 31, 1909. One male (dead) given to Capuchin (*Cebus* sp. *a*) was taken at once, and eaten without being removed from the mouth for inspection. This specimen, given with *Euchloë cardamines* (see p. 820), was used as a check upon the behaviour of the monkey towards *Euchelia jacobæ* and *Melitea artemis* (pp. 825 and 832).

Sept. 6, 1910. One offered to a Red-handed Marmoset was inspected, but not touched; but was eagerly taken and eaten by another animal of the same species. This Marmoset then ate a specimen of *Perarge megæra*, his behaviour suggesting that the two butterflies were equally palatable to him.

May 26, 1909. One chased at once by Shrike-Thrush and Dial Bird, but evaded them and escaped through the partition into next cage, where it was promptly caught on the wing by a Fantailed Flycatcher and eaten.

One caught at once on wing by Great Tit and eaten.

Aug. 21 to 27, 1910. One greedily eaten by cock Silver Pheasant.

One let loose in aviary skilfully dodged the swoop both of a Shama and a Wood-Swallow, and escaped.

One given to Dial Bird, which took it from my hands and damaged it by the peck so that it was unable to fly away. Again and again he pecked the butterfly as it fluttered about on the ground, but would not hold it. Ultimately it escaped under the partition into the next aviary, where it was pounced upon by a Weaver, which held it in his foot and ate it, leaving the wings.

Sept. 6, 1910. One taken by Masked Wood-Swallow and eaten after much delay and pecking. The bird evidently was not very keen on the insect; but he would not allow any other bird to take it from him. He did not once shake his head or wipe his beak as if there was any distasteful flavour.

One female taken and eaten by Ludwig's Bustard.

Sept. 7, 1910. One male and one female taken and eaten eagerly and with equal avidity by Green Lizard.

Larva of the Small White (*P. rapæ*), fed on cabbage.

Sept. 21, 1910. One tasted but rejected by Yarrell's Curassow and Globose Curassow.

THE GREEN-VEINED WHITE (*Pieris napi*).

July 31, 1909. One offered to White-tailed Mongoose, to three

Meerkats and to two Banded Mongooses. All rejected it after smelling it except the second Banded Mongooses, which took it with his paw, rubbed it in the sawdust, but would not eat it.

N.B.—The forceps with which this butterfly was offered had been previously used for *Ocypus olens*, *Curabus violaceus*, *Pterostichus niger* and *P. madidus*, and some *Timarchæ* as well as *Coccinella*, and probably the scent of these beetles was adhering to the steel.

May 26, 1909. One taken and eaten by Dial Bird, by Harmonious Shrike-Thrush, and by Blue Rock-Thrush.

July 26, 1909. One male given to Silver Pheasant, was taken from my fingers and swallowed instantly without being first deposited on the ground.

One female given to same bird was treated in exactly the same way.

These two I used as checks upon two specimens of *Melanargia galathea*, both of which the Pheasant treated very differently, spitting them out upon the ground after taking them from my fingers, and pecking them about a great deal before swallowing them (p. 827).

Aug. 21, 1910. One male greedily eaten by Silver Pheasant. This bird ate at the same time a specimen of *Epinephele jurtina*, showing an equal liking for both.

One male taken eagerly by Pekin Robin, which, after much pecking and tasting, left the butterfly uneaten.

July 31, 1909. One male eaten at once by Brazilian Hangnest.

Sept. 20, 1910. One left untouched by Fantailed Flycatcher. Taken and tasted but left uneaten by Dial Bird. Taken by Yellow-crowned Hangnest, which held the butterfly in his foot against the perch, pecked off its wings and finally picked it to pieces, and ate at all events most of it.

Note.—The Hangnests which ate these butterflies are much less typically insectivorous in diet than the Flycatcher, the Pekin Robin, and the Dial Bird, which refused them.

THE LARGE WHITE (*Pieris brassicæ*).

Oct. 26, 1909. One taken from my hand and greedily eaten by Lion Marmoset.

May 26, 1909. One taken at once by Syrian Bulbul and eaten; also by Harmonious Shrike-Thrush.

Oct. 26, 1909. One taken from my hand and greedily eaten by cock Silver Pheasant and by Honduras Turkey.

One taken by Shama and finally eaten, but not with any approach to the readiness with which he had just previously eaten a Tortoise-shell and the *E. jurtina*. At one time I thought he was going to give it up; but finally he swallowed it.

One liberated in aviary was chased up and down by three Wood-Swallows which, however, owing to hesitancy at the moment

of coming to close quarters, did not catch it. It escaped into another compartment, and was promptly seized by the Harmonious Shrike-Thrush, which ate it after a deal of pulling about and tasting.

Aug. 21, 1910. Two males greedily eaten by cock Silver Pheasant.

One male caught by Pekin Robin and eaten after some time, the delay being caused not apparently by distastefulness, but by the difficulty of getting rid of the wings which were left uneaten. This bird held the insect to the perch with his foot when pecking.

One male eagerly taken by Pearl-spotted Owl, which held it up in one foot while pecking it. He pecked away for some time at the thorax and wings without making much headway. He then shifted it and pecked off the end of the abdomen. But as soon as he got the flavour of the exposed tissues he shook his head and repeated the shake with every taste, showing unmistakable signs of disliking the flavour. Finally he hopped to another perch, put the butterfly down, and after looking at it for a little time, flew away. I thought he had given it up; but upon returning to the cage ten minutes later the butterfly had disappeared.

One put into an aviary of Tanagers was chased by several birds which, however, hesitated at the critical moment to catch it, as if a little doubtful as to its nature. At last a male Scarlet Tanager took it in his beak, but not having the instinct to use his foot to hold it or to put it into a cranny, went on masticating it for at least five minutes without showing any signs of dislike. He apparently refrained from swallowing it on account of the wings. Ultimately he was robbed by a female of the same species, which, after getting rid of the wings, continued pecking and tasting and shaking her head in the intervals, quite obviously not enjoying the flavour. She managed the insect better than the male, jamming it first into a split orange, and then between the leaves of a palm to peck it the better. Ultimately she ate what was left of the body.

One male offered to a hen King Bird of Paradise. She looked at it and as soon as she saw the legs move took it, but dropped it at once to the bottom of the cage. After careful and long inspection, she pecked it once or twice, but showed no eagerness to eat it. I then gave the same insect to a Larger Hill Mynah, which soon swallowed it, wings and all.

One male taken and eaten at once by Ludwig's Bustard.

One male offered to Fantailed Flycatcher, but he would not touch it. Taken and tasted by Dial Bird, but left uneaten. Also taken and tasted by Black-winged Grackle, and left and subsequently refused twice. Quickly eaten up by Harmonious Shrike-Thrush.

Sept. 18 to 20, 1910. One caught on wing by Fantailed Flycatcher, which had just eaten a 'Blue.' He carried it to a window-sill, but after one or two pecks left it. Once or twice the

bird, after waiting a short while, tried it again, but finally left it alone.

It was then taken by a Dial Bird, which, after pecking it about for a short time, was robbed by the Sulphury Tyrant. The latter, after tasting it, left it alone. I then gave the remainder of the insect, consisting only of the thorax and wings, to a Yellow-crowned Hangnest, which took it to a perch, and holding it in one foot gradually pecked away the wings and dropped them, and then pecked the thorax to pieces, eating little bits of it and dropping others.

Pupa of the LARGE WHITE (*Pieris brassicæ*).

Oct. 26, 1909. One offered to the Dial Bird which had fifteen minutes previously eaten the larva, but he would not touch it.

Offered to Yellow-crowned Hangnest which had tasted and dropped the larva. He looked at it but would not touch it.

Given to Harmonious Shrike-Thrush, which behaved just as the Dial Bird had behaved with the larva, pecking it and dropping it repeatedly to shake his head. He was then robbed of it by a Common Mocking Bird, which, however, dropped it in the grass from the perch, and made no attempt to recover it.

One offered to a Black-winged Grackle, a Javan Pied Mynah, a Fantailed Flycatcher, and a Sulphury Tyrant, all of which tasted it once, but not a second time. A Common Mocking Bird persevered a little longer, but finally dropped it and made no effort to pick it up again. Given to Harmonious Shrike-Thrush, was eaten without much hesitation.

Larva of the LARGE WHITE (*Pieris brassicæ*).

Food not recorded.

Oct. 26, 1909. One taken by Yellow-crowned Hangnest, but soon dropped. Pounced upon by Dial Bird, which after many trials, pecking it and shaking his head after every taste, at last swallowed it; but he was evidently very uneasy for some twenty minutes afterwards, periodically shaking his head and opening his mouth and straining as if trying to vomit something nauseous.

Larvæ of the same fed on *Tropæolum* (so-called Nasturtium).

Sept. 13, 1910. Three eaten readily by Silver Pheasant and Reeves's Pheasant.

A small one given to Pekin Robin, which obviously did not like the flavour. He pecked it about in the sand for a long time, vigorously shaking his head after each taste. Ultimately, however, he ate it. I then gave him as a test the larva of a *Noctua* (see p. 835), which he also took and very soon swallowed entire without once shaking his head or evincing any sign of dislike. He then took a second and larger *brassicæ*-larva, treating it just as he did the first, but tackled it with still greater reluctance,

allowing himself to be robbed of half of it by another bird of the same species. The two finally finished it between them.

One given to a Shama, which after pecking and tasting it for a long time, with much headshaking, left it. It was then tasted by a Wood-Swallow, which left it after one peck. The Shama then tried it again, but left it. Then a Red-vented Bulbul took it, but soon dropped it. The Shama then tried it again and ended by eating it. This Shama was the same bird that ate the *Coccinella 7-punctata* (p. 846).

One given to Kagu, which after several attempts left it; and immediately afterwards greedily ate the larva of a *Noctua* (p. 835). This same Kagu ate *Timarcha tenebricosa*.

One taken by Green Hangnest, which at the time was greedily eating mealworms. The bird finally ate it, but evidently did not much like it, putting it down several times, and wiping it in the sand.

One given to Pearl-spotted Owl, which dropped it at once.

One given to Butcher Crow, which dropped it directly; but afterwards picked it up and swallowed it whole. Immediately afterwards, however, he vomited it up and left it on the bottom of the cage.

One smelt, but not touched by Common Marmoset, and by Capuchin.

One eagerly eaten by Meerkat.

Sept. 21, 1910. Larvæ of the same, fed on cabbage (*Brassicæ*).

Taken and eaten by:—

Elliot's Pheasant, Reeves's Pheasant, and Silver Pheasant.

Vulturine Guinea Fowl. Crested Guinea Fowl. Ludwig's

Bustard. Vigors's Bustard. S. American Thicknee.

Cariama. Crested Curassow. Nigerian Ground-Hornbill.

Also by Meerkats and Banded Mongoose.

Tasted but rejected by:—Shama, Red-vented Bulbul, Green Hangnest, Black Hornbill, Elate Hornbill, Trumpeter, Yarell's Curassow, Globose Curassow, Crested Curassow, and Red-tailed Guan.

Notes.—The nature of the food of the larvæ did not appear to affect their taste. The Green Hangnest, it is true, refused larvæ fed on cabbage, having a week earlier eaten one fed on *Tropæolum*, but the bird was not eager for the latter, and I do not think this refusal of the former can be taken as strong evidence that he found them more unpalatable than the others. It is interesting that the Pheasants and Guinea Fowl, that is to say, Asiatic and African Gallinaceous birds, ate the larvæ eagerly, while the S. American Curassows and Guans, with the exception of one Crested Curassow, refused them after many trials, and much headshaking. One Curassow eagerly ate the larva of the *Noctua* (p. 835) after refusing that of *P. brassicæ*.

THE ORANGE-TIP (*Euchloë cardamines*).

July 31, 1909. One male given to *Cebus* (sp. *a*) was seized at once and stuffed into his mouth. He took it out, looked at it, smelt it, then ate it without hesitation.

This was a check experiment upon the behaviour of the monkey towards *Euchelia jacobaeæ* and *Melitea artemis*. He showed much greater alacrity in eating the *cardamines* than either of the others. A *Pieris rapæ* given at the same time he ate without removing it from his mouth.

May 26, 1909. One male taken by the Harmonious Shrike-Thrush after a few moments' inspection and eaten entire, wings and all, with much less delay in the way of pecking and scraping on the soil than the same bird displayed when dealing with *M. artemis* and *A. euphrosyne*. Tested by this bird, *E. cardamines* appeared to be more palatable; but it is possible, though I do not think probable, that he ate it with less delay because he had just previously been robbed of the specimen of *Argynnis euphrosyne* by not swallowing it at once.

Group NYMPHALINÆ.

THE SMALL TORTOISE-SHELL (*Vanessa urticae*).

Oct. 26, 1909. One taken and eaten by Shama which had just previously eaten *Epinephele jurtina*.

Hoopoe, Black-winged Grackle, and Harmonious Shrike-Thrush very eager to take one, but it was secured by the Grackle, which, however, was robbed by the Shrike-Thrush, the latter eating the butterfly in about half a minute without any signs of dislike such as shaking his head or wiping his beak.

Sept. 7, 1910. One taken and greedily swallowed, wings and all, by Dial Bird.

Sept. 18, 1910. One caught on wing by Fantailed Flycatcher, who carried it to a perch, but after a few tastes and pecks dropped it to the ground. Whether this was done intentionally or accidentally I cannot say, but the bird made no attempt to follow up the insect. I then gave it to a Dial Bird, which, after pecking it for a short time, was driven off by a Sulphury Tyrant. This bird, however, did not touch the butterfly. I then offered it to a Bulbul and a Yellow-crowned Hangnest; but neither touched it. I then offered it again to the Dial Bird, who finished it, but with no show of appetite. I am unable to say whether the indifference shown by the birds to this butterfly was due to its being distasteful or to the experiment being made at 5 P.M., when the birds had been feeding off and on through the day.

Pupa of *Vanessa urticae*.

June 24, 1909. One placed on a branch near a Shama was taken after a good deal of preliminary inspection but was soon

flicked away and fell to the ground. The bird made no attempt to recover it. I then again put it on the branch by his side, and on this occasion he pecked at the little stem to which the pupa was attached. A hen Black Tanager was the next to try it. She broke the shell and getting the taste flew away with the pupa and, I think, ate it. At all events she flew up to the top of some brickwork where I could not see her clearly, and presently came down again without the pupa; and on going up a ladder to look for the pupa, I could find no trace of it.

One offered to Syrian Bulbul was taken after some scrutiny. The bird flew away with it and pecked it, but seemed greatly bothered and puzzled by the tightness with which it adhered to the twig. He was unable to detach it from the twig, and finally left it. I then offered it to a Fantailed Flycatcher; but could not induce this bird to touch it, although he scrutinised it carefully and was hovering round me the while, apparently remembering that on previous occasions I had given him butterflies. I then gave it to the Harmonious Shrike-Thrush, which took it, pecked away at it until he broke off the tail-end and ate it. He then pecked off another piece and ate it, showing no sign of dislike. He then left the larger piece; but soon returned, broke it up, and finally ate it piecemeal.

From watching the behaviour of these birds, I should say that these pupæ are unpalatable only to the extent afforded by the hardness and toughness of the chitinous integument. The birds that tasted them after breaking the exoskeleton, showed no signs of disliking the flavour. Those that took them—and the Flycatcher could not be induced even to attempt it—did so after scrutinising them in a way that suggested doubt as to their belonging to the category of eatable things. They did not appear to me to know what they were; and none of the many insectivorous birds in the aviary showed the least sign of eagerness when I first put the pupa on a perch, waiting to see which would be the first to come down. It was only when I placed it about a couple of inches from the Shama, a tame and fearless bird, that he took it. The Tanager came, and after her the Bulbul, when they had seen the Shama's attempt, or at all events after the Shama had first tackled it. These birds are accustomed to visitors and keepers bringing food into the aviary; and I think it probable that the Shama was induced to peck at the pupa merely because it was definitely offered to him.

I suspect that this pupa is protected in the first place by its likeness to things inanimate, and in the second place by the toughness of its integument which does not readily yield to a peck, and is quite in keeping with the general impression of lifelessness suggested by the colour, shape, and immobility of the whole pupa. I may add that I did not see the pupæ move when pecked by birds, although they did so when handled by myself.

Young larvæ of *Vanessa urticae*.

June 24, 1909. One eaten without hesitation by Brazilian Hangnest, and by Common Mocking Bird; two by Shama; two by Orange-headed Ground-Thrush, and one by Harmonious Shrike-Thrush.

Two taken and tasted but whisked away by Larger Hill Mynah.

One taken and tasted but dropped by North American Cat-bird, which refused to touch a second.

One pecked and tasted many times, but finally rejected, by Fantailed Flycatcher.

THE PEACOCK (*Vanessa io*).

May 26, 1909. One fluttered to ground and rested with wings closed. A Fantailed Flycatcher flew down to inspect and was preparing to peck, when the butterfly opened its wings and moved them slowly up and down. The transformation seemed to disconcert the bird, which made no attempt to peck, but danced round the insect at a distance of about three inches. A Shama and another Flycatcher, which joined the first, behaved in the same way. A Syrian Bulbul then flew down and drove the three away. After inspecting the butterfly for about half a minute, he pecked the ocellus of the anterior wing of the left side; the second peck struck the ocellus of the anterior wing of the right side; the third the ocellus of the posterior wing of the left side, tearing a piece out. He was then driven away by a Sun-Bittern, which looked at the butterfly for some two minutes, but made no attempt to peck it, although it excited his interest. I then removed the Bittern; and the Bulbul returned at once, seized the butterfly by the head and thorax, flew away with it, and devoured it.

One fell to floor of aviary with wings closed, and was at once seized by Syrian Bulbul, before its wings opened, and was carried away and eaten. A second Bulbul of this species pursued the first; but I do not know which of these two birds was the one that ate the *io* first introduced.

The two features of interest in the first experiment with this species were, first, the manifest disconcertedness of the three birds by the sudden display of colour and the slowly waving wings of *io* (my wife, who was with me, said at once, "They are afraid of its eyes"); and secondly, the consecutive pecking of three of the ocelli by the Bulbul. It can hardly have been by accident that the ocelli were accurately struck three times running.

Aug. 21, 1910. A specimen let loose in aviary was chased by a number of Tanagers and other small birds and was caught by a Scarlet Tanager. The latter, however, was robbed by a Pekin Robin, which ate the insect without showing any signs of dislike, the delay of five minutes in finishing it off being caused by the difficulty of managing the wings which the bird ultimately broke off and left uneaten.

THE RED ADMIRAL (*Pyrameis atalanta*).

Aug. 21, 1910. One taken and eaten greedily by Lion Marmoset.

One pursued by Shama, which grabbed it by the hind wing and thereby lost the butterfly, which flew away and escaped through the wires of the aviary.

THE PAINTED LADY (*Pyrameis cardui*).

Aug. 27, 1910. One given to Pearl-spotted Owl was taken at once and swallowed entire after a little preliminary pecking.

This was a test experiment to ascertain the meaning of the bird's behaviour towards *Pieris brassicae* (see p. 817).

Araschnia levana. Late summer form *prorsa*.

July 8, 1911. One given to Harmonious Shrike-Thrush, an Australian bird, was taken at once, but after being pecked and tasted for some little time, was rejected. The remains were then greedily eaten by a Wood-Thrush, from North America. A fresh specimen given to this same Wood-Thrush was just as readily swallowed; but the Shrike-Thrush upon taking another, treated it as before, wiped it in the sand, shook his head, and allowed himself to be robbed by a Black-chinned Laughing Thrush, which ate it and another without hesitation.

One taken and eaten, but very slowly and with much pecking about, by a Hoopoe, which, after swallowing the last particle, appeared to try to vomit it back but without success.

A Blue Rock-Thrush and a Common Rock-Thrush, both European birds, each ate one greedily.

One pecked and tasted for some little time by Orange-headed Ground-Thrush, which obviously did not care for the flavour, and allowed himself to be robbed by the Blue Rock-Thrush mentioned above.

One liberated in aviary dodged the pursuit of a Shama and a Sibia with great skill, and escaped.

One given to Shama was pecked and tasted for some time, but the bird allowed himself to be robbed by a Wood-Swallow, which, after much pecking, swallowed the butterfly.

This performance was repeated exactly when one was given to the Sibia, the same Wood-Swallow taking it from him; but I think the Sibia would have eaten it ultimately.

One given to Grey-headed Friar Bird, from Australia, was taken and tasted for a long time and then dropped, given again to the same bird, was again tasted and dropped. The remains were then eaten without much delay by a Larger Hill Mynah.

One given to a Dial Bird was taken and after much tasting was resolutely rejected. The remains were then given to a

Sun-Bittern, which persevered for some time but finally rejected them.

The only birds which ate the butterflies quite readily were the two species of Rock-Thrushes, the Wood-Thrush, and the Black-chinned Laughing Thrush. To the others they were obviously more or less distasteful, the most significant rejection being by the Shrike-Thrush, which on previous occasions has eaten almost every insect offered to him.

N.B.—These experiments were made between 4 and 5 P.M., when the birds had been feeding throughout the day.

July 9, 1911. One eaten readily by Black-headed Lemur, one by Meerkat, two by Common Indian Mongoose.

Three eaten readily by two Wall Lizards.

Two eaten readily by Silver Pheasant, and one fairly readily by Manchurian Crossoptilon (Pheasant).

One given to White-eared Scops Owl was taken at once but dropped as soon as tasted.

Experiment repeated with same result.

Experiment repeated with same result with another specimen of the same species of Owl.

One given to Pekin Robin was taken at once, but put down upon the ground. For fully five minutes the bird continued to peck it and shake his head. He would neither eat it himself nor allow the other birds to take it from him. Ultimately he pecked it to pieces; but I cannot say whether he ate particles or wasted them on the ground. One thing was quite clear. He did not find the flavour to his liking.

DARK GREEN FRITILLARY (*Argynnis aglaia*).

July 21, 1909. One let loose in aviary was chased by Black-headed Sibia and Fantailed Flycatcher, but eluded both and escaped into a crevice. This is the first butterfly I have seen dodge the Flycatcher, which is extraordinarily adept at taking insects on the wing. I then gave it to the Spectacled Thrush, and he ate it after he had succeeded in shaking off its wings. The bird was keen not to lose it, and drove away the Flycatcher whenever he ventured near.

SILVER-WASHED FRITILLARY (*Argynnis (Dryas) paphia*).

July 26, 1909. One caught on wing and eaten with avidity by Fantailed Flycatcher.

Also used as check upon *Melanargia galathea* which the Flycatcher had rejected (see p. 827).

July 31, 1909. One eaten readily by Brazilian Hangnest.

PEARL-BORDERED FRITILLARY (*Argynnis (Brenthis) euphrosyne*).

May 26 to 31, 1909. One eaten by Silver Pheasant. For details see under *Melitaea artemis* (see p. 826).

Two specimens given respectively to Brazilian Hangnest, and to Saturnine Mocking Bird, were eaten much more readily than were specimens of *M. artemis* offered to the same birds (see under *Melitea artemis*).

One female taken by Harmonious Shrike-Thrush, but not eaten readily. While this bird was pecking the butterfly and wiping it on the gravel, he was robbed of it by a Red-vented Bulbul; the latter was in turn robbed of half of it by a North American Mocking Bird. The two finished it between them.

SMALL PEARL-BORDERED FRITILLARY (*Argynnis (Brenthis) selene*).

May 31, 1909. One taken and eaten by Capuchin, but without relish.

One taken and eaten by Capuchin (*Cebus* sp. *c*), with obvious avidity.

GREASY FRITILLARY (*Melitea aurinia* or *artemis*).

May 26 to 31, 1909. One male given to same specimen of *Cebus* that took the *Euchelia jacobæ* five minutes previously. He behaved in exactly the same way towards it. Stuffed it into his mouth, but the moment he got the flavour or the feel, took it out in his hands, pulled it to pieces, cautiously tasted it, and then ate it, but with no great show of satisfaction.

One taken and eaten by Capuchin (*Cebus* sp. *b*), but with great hesitation and no particular signs of relish. This monkey also ate one *Canonympha pamphilus*, one *Argynnis selene*, and one *Thanaos tages*; but treated them all in the same way, evidently not caring much for any of them. In this particular he showed a marked contrast to the two other examples of *Cebus*, sp. *a* and *c*, used for these experiments.

One male offered to Meerkat, taken and eaten at once. Eager for more.

One male offered to Capuchin, taken and eaten at once. Eager for more.

One male offered to White-handed Lemur, which after carefully smelling it, refused it.

Same one offered to Crowned Lemur and White-fronted Lemur, was smelt and refused in the same way.

Offered to Black Lemur, was smelt, then carefully taken into the mouth, but was then pulled out with the hand; then again tasted, but rejected as if distasteful, the tongue being rapidly protruded and drawn back through the front teeth as if to scrape off something unpleasant, perhaps scales.

One offered to Diana Monkey, was taken and eaten piecemeal, apparently with relish.

The mammals above mentioned had not been fed, and were without exception hungry.

One taken by Brazilian Hangnest, which pecked at it, ate a few pieces as if testing its flavour, then let it fall from the perch to the ground, and left it there.

One taken by Saturnine Mocking Bird, which shook it about, pecked it, ate a fragment or two, then left it.

One taken by Brazilian Hangnest, which pecked it several times, and finally ate it. The Mocking Bird then returned, and after many trials finished off the remains of the first specimen that had been left by the Hangnest and of the second that had been left by himself. It was quite evident that neither of these birds found much satisfaction in eating these butterflies.

One female liberated in aviary, caught on wing by Garrulous Honey-eater, and eaten without delay.

One female taken by Blue Rock-Thrush, but left on the ground after being pecked. Suspecting that his leaving it was due to my propinquity, I moved away and told the keeper to throw it to him, He then caught it on the wing, and ate it. He then came close to me on a perch and eagerly took another specimen (male) from my hand, then a third (female), and ate both greedily.

Two given to Silver Pheasant were taken and eaten, but with a great deal of pecking and tasting. Comparing this bird's behaviour towards them with his manner of eating *Pieris napi* and *rapæ*, I am quite sure he found them to a certain extent unpalatable. I thought at first that he merely disliked the wings. To test this I gave him immediately afterwards a specimen of *napi*. He took it from my hand and put it on the ground; then tasted it, and without more ado swallowed it. I then gave him a specimen of *rapæ*. He took it from me, and without putting it on the ground ate it up. I then gave him a specimen of *Perarge megæra*, which flew into a bush. He went after it, found it, caught it with the dexterity of a 'practised hand,' but treated it exactly as he treated the *artemis*, pecking and whisking it about, ultimately after much delay eating it piecemeal, but with what might be described as a very dubious air. He behaved in a precisely similar manner towards an example of *Argynnis euphrosyne*.

I am convinced that no one who had seen this Pheasant eat these five butterflies, could have doubted for a single moment that he found the 'Whites' pleasant to taste, and the 'Fritillaries' not altogether to his liking.

One male offered to Larger Hill Mynah was taken and eaten, but with no great relish, being frequently dropped and picked up again, and scraped in the sand.

One male offered to Levaillant's Barbet, which took it and behaved towards it in exactly the same way as the Mynah. The birds appeared to dislike the wings, and to want to get rid of them.

One male offered to Fantailed Flycatcher, which after a little inspection pecked it and took it, but was robbed by a Syrian Bulbul, which ate it.

Two males taken and eaten by Shama.

One male taken and eaten by Cape Robin-Chat.

One male taken and eaten by Indian Orange-headed Ground-Thrush, after being pecked and rejected by Hoopoe.

One male taken and eaten by Harmonious Shrike-Thrush.

One female taken and eaten after a great deal of pecking and delay by Indian Black-headed Sibia, which was chased for it by a Syrian Bulbul.

One female taken and eaten, after a few moments' inspection and biting at the wings before the position of the body was found, by a Sand Lizard. A Dugès's Lizard came up while the butterfly was being chewed, and after tasting it once or twice, attacked the Sand Lizard to make him relinquish his hold.

One male taken by the same Sand Lizard after he had finished the first specimen. I then made him drop it; and offered it to a Wall Lizard, which took it without delay and swallowed it.

Group SATYRINÆ.

THE MARBLED WHITE (*Melanargia galathea*).

July 24, 1909. As a check I first of all offered a specimen of *P. napi* to the cock Silver Pheasant. He took it from my fingers, and without hesitation swallowed it and turned eagerly for more. I then gave him a *galathea*, which he just as eagerly took, but promptly lowered his head to the ground and spat it out. He persevered with it, however, and after a little pecking and shaking, ate it. I then tried him with another *napi*. He took it and swallowed it at once, not hesitating for a single moment, exactly as he had done with the first one. Then I gave him another *galathea*, which he took but immediately put out of his beak upon the ground; but after some pecking and tasting he swallowed it.

I consider this bird to have rather a refined taste for insects; and I can now tell tolerably accurately by his behaviour whether he likes one or not. And I am quite sure that he found *napi* very palatable and *galathea* not so.

I then let a *galathea* loose in the aviary, and it was promptly caught on the wing by a Fantailed Flycatcher, which flew with it to the ground, and after pecking, pulling and shaking it about for a minute or so, gave it up and took no further notice of it. As a check I then tried him with *Aphantopus hyperanthus*, which he caught in the same way, and very quickly demolished. I then gave him another *galathea*, which he caught and pecked and shook for some little time; but he would not eat it. As a further check I gave him *Argynnis paphia*, which he caught and disposed of as quickly as he had disposed of the *hyperanthus*.

I noticed that some of these *galathea* had darker spots below than the others. Thinking that perhaps this might be a sexual difference, I gave one of each kind to the Pheasant and to the Flycatcher; but the birds behaved in exactly the same way towards them.

One caught and eaten by Dial Bird; also by Orange-headed

Ground-Thrush, and by White-cheeked Bulbul. The latter was robbed by the Harmonious Shrike-Thrush; but recovered the butterfly and ate it.

One given to Sulphury Tyrant, who pecked it and shook it for a long time, then allowed the Shama to take it from him. The Shama ate it. This was a *galathea* with lighter spots below.

One given to the same Shama was also eaten. This was a darker spotted specimen.

The specimen above alluded to that was rejected by the Flycatcher, was eaten by a North American Cat-bird (Thrush).

One offered to Australian Bustard, was taken from my hand and swallowed at once.

One given to Meerkat, was taken and eaten without hesitation.

One given to Capuchin, which by his rejection of the Telephorid beetle (p. 840) had shown himself to be more particular in taste than some others of his species, was eaten, but by no means greedily.

With the exception of the Australian Bustard none of the birds that ate the *galathea* did so with great alacrity. Swallowing them was in all cases preceded by a varying amount of flicking and shaking and pecking. When I began my experiments I thought this behaviour was due to a wish to get rid of the wings; but I am now doubtful about this, and believe that in many cases at all events it indicates dislike of the taste. When a butterfly is really to the liking of a bird, he disposes of the insect as fast as he can, without paying much attention to the wings. This struck me to-day particularly in the case of the Silver Pheasant when eating the *napi*, and of the Flycatcher when eating the *hyperanthus* and the *paphia*. The *paphia* especially was a large-winged butterfly for so small a bird; and yet he swallowed it, wings and all, in a few seconds.

THE MEADOW BROWN (*Epinephele jurtina* × *janira*).

July 21, 1909. One female eaten at once by Lion Marmoset, which had previously refused to taste the malacoderm beetle (*Rhagonyche*) and the Saw-fly (*Allantus arenatus*).

One female taken from my hand by Spectacled Thrush, but made his escape. Caught on wing by Fantailed Flycatcher and eaten at once.

One female eaten at once by Common Pheasant.

July 31, 1909. One male caught on wing by Black-headed Sibia and eaten at once; another (female) caught on wing and eaten without delay by Fantailed Flycatcher.

Aug. 21, 1910. One male greedily eaten by Silver Pheasant. This bird at the same time ate with equal avidity a male specimen of *Pieris napi*. Her behaviour indicated no difference of taste between the two butterflies.

Oct. 26, 1909. One female taken and eaten fairly readily by Shama.

THE LARGE HEATH OR GATEKEEPER (*Epinephele tithonus*).

July 31, 1909. One eaten at once by Brazilian Hangnest.

Aug. 25, 1910. One caught and quickly swallowed entire by Pekin Robin.

One male taken and swallowed entire with scarcely any delay by Pearl-spotted Owl.

Sept. 20, 1910. One caught on wing and eaten without delay by Fantailed Flycatcher. This bird would not touch two White Butterflies (*P. brassicae* and *napi*), offered one just before and one just after it took *tithonus*.

THE RINGLET (*Aphantopus hyperanthus*).

July 26, 1909. One caught on wing and eaten with all speed by Fantailed Flycatcher.

I used this specimen as a check upon *galathea*, which the bird had just refused to eat after catching it and pecking it about for some time.

One gobbled up at once by Silver Pheasant.

THE SMALL HEATH (*Cænonympha pamphilus*).

May 26, 1909. Two taken and eaten at once by Fantailed Flycatcher.

One taken by Fantailed Flycatcher which was at once chased by Syrian Bulbul.

One seized by Orange-headed Thrush, which after carrying it about gave it through the bars of the partition to another bird of the same species. This was deprived of it by a Bower Bird, which carried it about, perhaps as a possible ornament, since he made no attempt to eat it.

THE WALL BUTTERFLY (*Perarge megcera*).

May 31, 1909. One taken and eaten by Capuchin (*Cebus* sp. *b*), but without apparent liking (see under *Melitæa artemis*).

One taken and eaten with avidity by Capuchin (*Cebus* sp. *c*).

Aug. 25, 1910. Eagerly taken and eaten by Red-handed Marmoset.

May 31, 1909. One eaten by Silver Pheasant (see also under *Melitæa artemis*).

Aug. 25, 1910. Two (male and female) caught and greedily eaten, wings and all, by Pekin Robin.

Sept. 5 to 7, 1910. One female taken at once by Ludwig's Bustard, which, however, let it escape. It was caught on the wing and quickly eaten by a Larger Hill Mynah. Two more specimens (female) eaten by Black-winged Grackle and by Dial Bird.

THE GRAYLING (*Satyrus semele*).

July 31, 1909. One caught on wing by Fantailed Flycatcher and eaten with all speed.

Group LYCENIDÆ.

COMMON BLUE (*Lycæna icarus*).

Oct. 26, 1909. One given to Shama, but it avoided him and flew through into the next compartment, where it was captured smartly by a White-browed Wood-Swallow, and eaten as soon as the bird could get peace from the pursuit of two other Wood-Swallows in the same compartment.

N.B.—These Wood-Swallows were desperately keen to get the butterflies with which they saw me feeding the Shama in the next compartment.

One male let loose in aviary containing Fantailed Flycatcher, which I should describe as an expert butterfly-catcher. But the Blue dodged him again and again, and got through into the next compartment. Here again it avoided the swoop of one or two birds whose identity I did not detect in my intentness in keeping my eye on the butterfly. The latter then passed through to a third compartment and settled on some yellow painted boarding, which it did not match, and on which it was caught by a Brazilian Hangnest, and quickly eaten.

One male caught deftly by Masked Wood-Swallow, which after prolonged pecking and tasting, swallowed the body, having got rid of the wings. This bird used its foot to hold the insect down.

One male caught by Pekin Robin and ultimately swallowed entire; but the bird put the insect down many times before swallowing it.

The behaviour of these two birds suggested that this 'Blue' was not very palatable. Its size offered no obstacle to its being swallowed at once; but both birds delayed over the meal.

Two (male and female) given in succession to Pearl-spotted Owl were taken and swallowed entire without delay.

Two (male and female) let loose in aviary were captured and quickly swallowed entire by Pekin Robin.

THE BROWN ARGUS (*Lycæna astrarche*).

Sept. 18, 1910. One let loose in aviary was taken by a Cayenne Tanager, which was quickly robbed by a Pekin Robin. The latter ultimately swallowed it entire, after putting it down several times before finishing it off.

One caught on wing and eaten at once by Fantailed Flycatcher.

One caught and eaten at once by Dial Bird.

THE SMALL COPPER (*Chrysophanus phlaeas*).

Aug. 25, 1910. One caught and swallowed quickly, wings and all, by Pekin Robin.

Group NEMEOBIINÆ.

THE DUKE OF BURGUNDY (*Nemeobius lucina*).

June 15, 1909. One given to Brazilian Hangnest was taken and swallowed without any hesitation.

One given to Saturnine Mocking Bird was taken at once, but not eaten eagerly. While she was pecking it about a Lesser Hill Mynah flew up and took it away, but was in turn deprived of it by the Mocking Bird, which then swallowed it quickly.

Two given to Silver Pheasant, which ate them with the same eagerness as it had previously shown when tried with the 'Whites.'

Group HESPERIIDÆ.

THE DINGY SKIPPER (*Thanaos tages*).

May 31, 1909. One taken and greedily eaten by Dent's Monkey.

One taken and eaten cautiously by Capuchin (*Cebus* sp. *b*). See under *M. artemis*.

THE LARGE SKIPPER (*Argiades sylvanus*).

July 21 to 31, 1909. One caught and eaten at once by Fantailed Flycatcher, and one by Brazilian Hangnest.

Moths.

Larva of GOAT-MOTH (*Cossus ligniperda*).

Sept. 20, 1909. One taken first of all by Dial Bird, which after a short time was driven off by Sulphury Tyrant. Both, after pecking it, left it practically uninjured on the ground. It was then taken by the Harmonious Shrike-Thrush. He kept it for some time, pecking it about and was eager to prevent other birds getting it; but was finally beaten in a 'tug-of-war' for it by a Common Hangnest, which carried the grub to a bush, held it against a branch with his foot, and pecked away for five minutes, then voluntarily dropped it. It was then taken by a Dial Bird, which persevered for a long time, pausing frequently between the pecks, opening and shutting and wiping his beak. He was then deprived of it by a Black-chinned Laughing Thrush, which kept it for ten minutes, pecking and whisking it about without making any visible impression on the skin. The head, however, was by this time gone, and the bird pulled some soft tissues out of the end and ate them. I then gave it to a Green Hangnest, but after tasting it he let it drop and took no further notice of it. I then gave it to a Leach's Laughing Kingfisher, which after a little delay swallowed it whole.

Larva of the LACKEY (*Clisiocampa neustria*).

Sept. 20, 1909. Seized at once by a Shama which flew away with it, holding it by the head; but while he was adjusting it for eating, the female Black Tanager grabbed the other end and being victorious in the tug that ensued, carried away the larva and, after a good deal of pecking, ate it.

SIX-SPOTTED BURNET (*Anthrocera (Zygæna) filipendulæ*).

July 31, 1909. One placed on a branch was immediately seized, but flicked away by a Black-headed Sibia, which made no attempt to follow it up but flew away, shook his head once or twice, and wiped his beak.

Sulphury Tyrant then pecked it and flicked it away; and tried it again with the same result, and left it.

Harmonious Shrike-Thrush took it eagerly, wiped it on the ground several times, then jammed it into a forked branch and started gingerly pulling it to pieces with much shaking of his head and wiping of his beak. He then broke it in two pieces; flew away with one and pushed it into a cranny and still persevered. He then broke another piece off, and stuck it in a cleft branch; but finally left it. I did not see him eat any of the moth although he may have swallowed small particles. In any case there were pieces of it left in the places where he had fixed them.

THE CINNABAR MOTH (*Euchelia jacobææ*).

July 31, 1909. One given to Meerkat, which caught it on the wing with a snap, devoured it with every sign of relish, and seemed eager for more.

One given to Capuchin (*Cebus* sp. *a*), which stuffed it into his mouth at once, chewed it, then hastily took it out again, apparently finding he had something either unusual or unpleasant on his tongue; smelt it, pulled it to pieces with his hands, and finally ate it, but with a good deal of doubt as if undecided as to whether it was nice or nasty.

July 5, 1909. One specimen offered to a Fantailed Flycatcher was immediately seized and pecked and tasted; and then rejected. The Shama then tried it, and treated it in the same way, finally rejecting it. A second Flycatcher then tasted it, and rejected it.

Another specimen of the moth let loose in this aviary flew through the wires into another compartment, and was captured on the wing by a Pied Grallina. He pecked it once or twice, and tasted it, then flew away. A Cuban Mocking Thrush then came up, and while he was looking at it and hesitating to peck, the Grallina came back, drove away the Mocking Bird, seized the moth and gradually ate it, holding it in one foot and pecking it to pieces.

Larva of Cinnabar Moth.

Aug. 15, 1909. Inspected but not touched by English Thrush.

Offered to many fowls, only one of which pecked it, but dropped it at once and took no further notice.

MAGPIE MOTH (*Abraxas grossulariata*).

Aug. 1909. Offered to fowls, was inspected by several, but only pecked by one, which at once dropped it, and made no further attempt.

Small Green Geometria larva, probably of *Cabera pusaria* or *ecanthemaria*.

May 26, 1909. One taken without any hesitation by a Shama; but dropped. Then taken a second time, and dropped. When preparing to take it a third time, he was deprived of it by a Black-headed Sibia, which after spending a few seconds adjusting it in his beak, swallowed it. It appeared to me that the Shama dropped this larva accidentally, owing to lack of skill in adjusting it in his beak, rather than intentionally. He was just as eager to take it, although dead, the third time, as the first.

THE SWALLOW PROMINENT (*Pheasia dictæa* or *tremulæ*).

July 12, 1909. Flattened itself to the ground but was at once pounced upon by the same Flycatcher that had just eaten the Hemerobid (see p. 835). The bird, without any hesitation, ate it with all speed, being merely delayed by the trouble of adjusting the wings. Both this moth and *Manestra persicariæ* betrayed their identity as Lepidoptera by flying out of the boxes to the ground, so I had no chance of judging whether the Flycatcher or other birds would have been deceived by their procrystic coloration.

THE BUFF-TIP (*Phalera bucephala*) (imago).

July 5, 1909. Not being aware of this moth's propensity, I picked it up by the wings, whereupon it immediately twisted its abdomen round and ejected a stream of white fluid over my fingers. I regret that I missed seeing this defensive device practised on a bird. However, I placed the moth on a wooden branch, and a Fantailed Flycatcher flew down to inspect it; after looking at it for a few seconds, he flew away. I then put it near a Shama, who hopped up to it and almost immediately picked it up by the thorax. The other birds in the aviary now became interested and pursued the Shama, giving him no chance of eating it. When on the wing he dropped the moth, and the Fantailed Flycatcher, which had previously taken no notice of it,

immediately pounced on it, and after one or two efforts swallowed it at a gulp.

My impression is that the Flycatcher did not suspect the moth of being eatable until he saw the Shama take it. It certainly looked very like an inanimate excrescence as it rested on the perch. Presumably the moth had exhausted its intestinal artillery upon me, because it shot out no more when seized by the birds, but kept perfectly quiet without even flapping its wings, although the Shama did not crush it, and having it end on by the thorax with the moth's head in his mouth, left the wings perfectly free to flap, and the abdomen to wriggle, had the moth been disposed to struggle. This behaviour, I take it, was a manifestation of the deeply implanted instinct to keep absolutely still (commonly called 'death-feigning'), which is so highly developed in many animals with procryptic shape and colour.

THE DOT (*Mamestra persicarice*).

July 12, 1909. One flattened itself to the ground, and was seized by the Fantailed Flycatcher that had eaten *Pheasia tremulae*, and was eaten with avidity, delay, however, being caused by the bird's desire to get rid of the wings as well as by being disturbed by another Flycatcher and a Syrian Bulbul, which tried to deprive him of the moth. The Bulbul subsequently picked up the pieces of wing and ate them.

Larvæ of the BRIGHT-LINE BROWN-EYE (*Mamestra oleracea*).

Oct. 26, 1909. One given to Harmonious Shrike-Thrush was taken after a moment's scrutiny. He pecked it, and tasted it three or four times, then swallowed it readily enough. His behaviour suggested to me a certain amount of caution at first, as if he remembered the distastefulness of the pupa of *Pieris brassicae* which he had just previously eaten. The green hue of both gave them a superficial similarity to one another. Having eaten the one specimen of *oleracea* he was very keen to get the second.

This I gave to the Black-winged Grackle which a few minutes previously had unhesitatingly left the pupa of *P. brassicae* after one taste. He took it, and after a taste or two proceeded to eat it with avidity, not giving the Shrike-Thrush, who was hovering near and following him up for an opportunity to snatch it, a chance to do so.

Larva of DRINKER (*Cosmotricha potatoria*).

May 26, 1909. One thrown to floor of aviary, was followed by many birds and secured by a female Black Tanager, which carried it to a perch and proceeded to peck it and shake it for about one minute. She then dropped it, and it was seized by the Black-headed Sibia, but was dropped at once. The Tanager thereupon tried it again; and again let it fall, this time almost

immediately. Two Fantailed Flycatchers then came up and inspected it. One of them pecked it, but let it alone after one experimental taste. The larva was by this time dead. Then a Sulphury Tyrant came up, picked it up and after a peck or two swallowed it.

Larva of *Noctua* (unidentified).

May 26, 1909. Two (fed on *Tropæolum*, so-called Nasturtium) eagerly eaten by Pekin Robin and by Kagu.

One (fed on cabbage) was readily eaten by Yarrell's Curassow, which had just rejected the larva of the Large White (*Pieris brassicæ*) and of the Small White (*P. rapæ*).

Order NEUROPTERA.

HEMEROBIID (unidentified).

July 12, 1909. One turned loose in aviary was at once caught on the wing by Fantailed Flycatcher and eaten without hesitation. The bird wiped its beak two or three times on a branch afterwards; but I do not think this action can be regarded as a certain sign that it wished to remove something unpleasant. It suggests the possibility, however, especially in view of the fact that the action was not repeated by the same bird after greedily eating *Pheasia dictæa* and *Mamestra persicariæ*.

Large Black and Yellow DRAGON FLY
(*Cordulegaster annulatus*) male.

July 26, 1909. One pounced upon and eaten after a time by Harmonious Shrike-Thrush.

Order ORTHOPTERA.

COMMON GRASSHOPPER (*Stenobothrus* sp.).

Sept. 6, 1910. One given to Pekin Robin was eagerly taken and eaten, but not with great rapidity, the bird putting it on the ground between the pecks, but without once shaking his head or showing any signs of disliking the taste. He appeared to me to be troubled by the insect's legs.

GREAT GREEN GRASSHOPPER (*Locusta viridissima*).

All the birds in the aviary were keen to get it. It was tackled at once by a Dial Bird; but he was driven off by a Black Tanager, who flew away with the insect and pulled it to pieces on the top of a wall.

SUMATRAN STICK INSECT (*Lonchodes* sp.).

Taken and eaten at once by:—Pinché Marmoset, Lion Marmoset, Douracouli, Capuchin, and Banded Mongoose.

Taken in the hand, but put down untasted and unhurt by Grey Lemur.

Taken and eaten at once by:—Silver Pheasant, Cartagenian Motmot, Fantailed Flycatcher, two Dial Birds, Shama, Black-chinned Laughing Thrush, two White-crested Jay-Thrushes, Black-winged Grackle, Chinese Mynah, Brazilian Hangnest, and Shrike.

The Shrike was too shy to take the specimen from my fingers, so I threw it towards him on the sand, not seeing exactly where it fell. He, however, saw the direction of the falling insect, and hopped towards it, but somewhat to my surprise—for birds seldom lose sight of thrown food—did not pick it up but looked as if inquiringly up at me. After a little search I found the small Stick Insect on the sand lying still with legs extended, and looking exactly like a blade of green grass. When I stirred it up and made it crawl, the Shrike was on to it in a moment; and I have no doubt that he missed it in the first instance owing to its resemblance to the grass blade.

I observed that several of the birds looked inquiringly, as I should describe it, at the Stick Insects before taking them. One in particular, the Harmonious Shrike-Thrush, usually one of the keenest insect-eaters in the Gardens, hesitated on two occasions so long before making up his mind to touch them that he was promptly robbed of his prey, once by a Dial Bird and once by the Black-chinned Laughing Thrush.

Two birds took them directly, but instead of eating them, hopped about with them in their beaks. One of these, the Green Hangnest, was deprived of his by a Chinese Mynah, which took it from him through the partition bars of the next aviary; the other, a Grey Struthidea, was similarly robbed by a White-crested Jay-Thrush after a Collared Jay-Thrush had made several attempts to get it from him.

Order COLEOPTERA.

Group GEODEPHAGA.

The species of this group used for the test belonged to the Carabidæ, a family of carnivorous ground-beetles with an exceedingly hard exoskeleton. *Carabus violaceus* is black with blue reflections; the species of *Pterostichus* are dead black and shine like pitch. *Harpalus* has pubescent elytra and is a little less conspicuous.

Carabus violaceus.

July 31, 1909. One rejected, after being smelt by three Meerkats, two Banded Mongooses, and one White-tailed Mongoose. The latter behaved towards it exactly as he did towards the *Ocypus olens* (see p. 838).

Offered same specimen to Harmonious Shrike-Thrush, which seized it eagerly but was robbed by the Dial Bird. I am sure by the way they tackled the beetle that either of these birds would have eaten it; but the Spotted Bower Bird robbed the Dial Bird, as in the case of *O. olens*, and finally finished it.

July 31, 1909. One dropped on to floor of cage of the Meerkat which had just eaten a *Timarcha tenebricosa*. He pounced on it, but would not seize it as he did the *Timarcha*. I think he bit it, but am not sure. However, by the way he pawed it about I am convinced he did not care for it. While he was holding and smelling it, he quite suddenly let it go and vomited up the *Timarcha* (see p. 841). The *Carabus* escaped unhurt. I then gave it to a Capuchin which seized it, and was proceeding apparently to eat it when another snatched it from him and ate it without showing any marked signs of dislike, but with no great avidity.

This species, like others of the genus *Carabus*, discharges from its mouth when handled a most repulsive smelling fluid.

Mr. Beddard found that *Lacerta ocellata* ate this beetle.

Pterostichus (Abraax) striola.

July 26, 1909. One taken by Sulphury Tyrant which shook it and pecked it for some time until robbed of it by Spectacled Thrush. This bird also pecked it and banged it about until robbed by female Black Tanager, which ultimately ate it after much pecking and tasting.

The delay in eating this beetle on the part of the birds that tried it may have been due to its hard exoskeleton or to partial unpalatableness from other causes. The hardness alone would, I think, account for it.

One (dead) given to Silver Pheasant was swallowed entire with very little delay. The bird, however, after taking the insect from my fingers, put it on the ground as is his custom with anything hard or with soft butterflies not quite to his liking.

July 31, 1909. One seized and bolted at once by Silver Pheasant in exactly the same way that he had bolted the other Carabidæ.

Pterostichus niger.

July 31, 1909. One smelt but rejected by three Meerkats; snatched from the forceps by a Common Indian Mongoose, which followed it and watched it, and smelt it as a cat does a cockroach, but did not eat it, so I took it from the cage uninjured. White-tailed Mongoose turned from it in disgust.

One seized and bolted at once by Silver Pheasant.

According to Mr. Beddard this beetle was eaten without hesitation by *Lacerta vivipara* and another lizard: and with some hesitation by Finches.

Pterostichus (Steropus) madidus.

July 31, 1909. One smelt and refused by three Meerkats. Seized and eaten by White-tailed Mongoose. This Mongoose is a large animal approaching a cat in size.

One seized and bolted by Silver Pheasant.

One pecked twice by Elliot's Pheasant, but escaped into the grass unhurt.

One seized and eaten by Black-headed Sibia.

Harpalus ruficornis.

July 21, 1909. One pecked at twice by Silver Pheasant but not eaten, the bird taking no further interest in it after the second peck. The beetle escaped unhurt.

Group BRACHYELYTRA.

DEVIL'S COACH-HORSE OR COCK-TAIL BEETLE (*Ocypus olens*).

(Uniformly velvety black in colour.)

July 31, 1909. One smelt and rejected at once by three Meerkats, one Mongoose, one Banded Mongoose, and by the White-tailed Mongoose that had just before eaten the *Timarcha* (see p. 842). This Mongoose started away from the scent in a way that reminded me of the behaviour of a person who finds a bottle of smelling salts unexpectedly pungent.

Offered the same specimen to Harmonious Shrike-Thrush, which tackled it at once, but while pulling it to pieces was robbed by the Dial Bird, and this bird in turn was robbed by a Spotted Bower Bird, which ate it.

Note.—The difference between the Viverrine mammals and the birds in their behaviour towards the Ground Beetles (Carabidæ and *Ocypus olens*) was very marked, and is to be in a measure explained, I think, by the wide difference in their powers of smell. The beetles appear to be relished by the birds; but to be nauseous to the mammalia. This perhaps is natural; because the Passerine birds would seldom come across the Ground Beetles, which are cryptozoic and largely nocturnal. The mammals like the Meerkats, and the Mongooses, on the other hand, must commonly find them as they grub about and hunt for food on the ground. Therefore one would expect protective attributes, if existing at all in these beetles, to be of a kind to guard them against being eaten by Meerkats or insectivorous mammals of similar habits.

The Silver Pheasant which ate these beetles is essentially a diurnal feeder and would seldom find nocturnal beetles. After seeing him eat the *Pterostichi* as if they were large seeds, I do not understand why he did not eat the *Harpalus ruficornis* offered to him some time previously*.

* Mr. G. A. K. Marshall suggested at the meeting when this paper was read that the *Harpalus* had retained while the *Pterostichi* had discharged their acrid juices.

Group LAMELLICORNIA.

DUNG BEETLE (*Geotrupes vernalis*).

July 23, 1909. Offered to Pearl-spotted Owl, which blinked at it, but refused to touch it. Offered to a White-eared Scops Owl, was at once taken and held up in one foot; but after a few pecks, which removed some legs, it was let fall, no effort being made to recapture it. Given to a Ludwig's Bustard, was eagerly taken, and swallowed whole after a few pecks.

The large COCKCHAFER (*Melolontha vulgaris*).

July 23, 1909. One dropped on floor of aviary was pounced upon by Indian Dial Bird which had just before been trying the *Timarcha*. He pecked it, hammered it with his bill, and after a great deal of difficulty broke it in half. He evidently liked it, because he would not give any other bird a chance of getting it. However, when he had broken it up, the Harmonious Shrike-Thrush secured one half and carried it away, and after pecking it for a few minutes swallowed it. The Dial Bird in the meantime finished off his portion.

STAG BEETLE (*Lucanus cervus*) male.

July 31, 1909. This I showed to some Capuchins, which evinced the greatest eagerness to secure it, but no sign of fear. I gave it to one, and his first act was to bite off the mandibles. This may have been an accident, but it reminded me of the alleged action of baboons in removing the stings of scorpions before they can do any damage with them. He then bit off the legs, finding they worried him, and sitting down munched up the beetle as if it had been a bit of apple. On a previous occasion I gave a dead Stag Beetle (male) to some Brush Turkeys. One seized it and was promptly chased round and round the enclosure by the others, which evinced the greatest keenness for a share. I could not wait to see what ultimately happened to the insect.

Group LONGICORNIA.

Strangalia armata, the only species of this group experimented with, is a black and yellow, somewhat wasp-like flower-haunting diurnal beetle, with a very hard exoskeleton.

July 21 to 31, 1909. One taken at once from my hand by Silver Pheasant and eaten after a good deal of pecking and breaking up. The way the bird persevered with this hard-shelled beetle shows that his rejection of the *Harpalus* was not due to its hardness (p. 838).

One offered to Fantailed Flycatcher, which, however, would not touch it. Black-headed Sibia took it without hesitation, and flying away with it pecked it to pieces and finally ate it. Further

evidence of the bird liking the insect was shown by the way he flew away with it when chased.

One taken and eaten by Dial Bird, which was apparently only delayed in disposing of it by the hardness of the exoskeleton.

One taken and similarly disposed of by Great Barbet.

One eaten after being broken up and crushed by Brazilian Hangnest.

Group MALACODERMATA.

The beetle of this group used for the experiment is a flying diurnal flower-haunting species, with a soft exoskeleton. It is quite fearless of exposure. Beetles allied to it commonly form centres of mimetic attraction in the tropics.

TELEPHORID (? *Rhagonyche fulva*).

July 21, 1909. Four offered to four Capuchins were eaten, two readily and without examination, two after a good deal of tasting and examination between the tastes.

Two offered to two Capuchins were taken into the mouth, tasted, then taken out, wiped on the bars and left.

One refused by Ceylonese Macaque after being smelt.

One eaten by Mona Monkey after a good deal of tasting, smelling and pulling about. This Mona also ate the bug *Tropi-coris rufipes* (p. 847).

One offered to Lion Marmoset was taken in the hand, smelt, and promptly dropped. The Marmoset then descended from the perch, picked it up again, smelt it and dropped it. The beetle crawled away unhurt.

One smelt once or twice by Meerkat, was rejected without being tasted.

One taken by Silver Pheasant, was pecked twice and left alone. Another offered to same bird was pecked once and left. One taken by Fantailed Flycatcher was pecked and tasted, then left. The same specimen was then pecked once or twice by a Shama and rejected. Black-headed Sibia then tried it, but gave it up and vigorously wiped his beak after a taste or two. Afterwards he made another attempt with the like result. The Black Tanager then took it, tasted it, wiped his beak and rejected it.

One caught on wing by Harmonious Shrike-Thrush was eaten after much pecking and pulling about. Another was treated in the same way by this bird.

Two specimens, one of which was dead, offered to and eaten by Dial Bird.

One tasted two or three times by Shama but rejected.

One pecked by Black-chinned Laughing Thrush, but flicked away. Pounced on and eaten by Dial Bird.

Although eaten by the Dial Bird and the Shrike-Thrush, which ate most of the insects offered to them, and by some of the

Monkeys, there can be no doubt that this soft-shelled beetle possesses distasteful attributes. Its rejection by the Meerkat, which ate nearly all the insects offered to it with the exception of *Coccinella 7-punctata*, was very significant, and suggestive of nasty smelling secretions.

Group PHYTOPHAGA.

The three species of this group that were tested are well-known species. They are slow-moving diurnal forms found on plants of different kinds. They are squat in shape, dorsally convex, and have a very hard exoskeleton, the Ladybird (*Coccinella*) being in addition exceedingly slippery and difficult to hold. The coloration of the latter is orange with black spots. The others are uniformly black or blue. *Timarcha tenebricosa*, the familiar 'bloody-nose beetle,' is further notorious for the discharge from its mouth of a crimson liquid, whence the trivial name is derived.

Chrysomela polita.

July 31, 1909. One offered to Meerkat was smelt and refused. Another Meerkat in the same cage took it in his mouth, but spat it out; both then sniffed it as it lay on the ground, but would not touch it.

The same specimen, offered to a Grison, was sniffed but not touched. Snapped up by McCarthy's Mongoose; but was at once spat out and left. It was then taken and eaten by a Banded Mongoose.

Query: Had the previous tasters exhausted the Beetle's supply of nauseous juices?

One given to Dent's Monkey was taken, rubbed between the hands and in the sawdust, smelt, tasted, pulled about and rejected. Picked up by Mona in the same cage, but rejected after one taste. This Mona had just eaten a living *Bombus*.

One given to Harmonious Shrike-Thrush was taken, pecked and tasted for a little, then left. Picked up by Black-chinned Laughing Thrush, was pulled to pieces, and rejected. This bird may have eaten pieces of the beetle, but the other debris was left on the turf. He did not appear to find it very unpalatable. Possibly in this case the nauseous juices had been exhausted by the Shrike-Thrush.

One pecked off a perch by Fantailed Flycatcher, but not followed up. Pecked and tasted by Sulphury Tyrant, but left. Then tried by Sun-Bittern, but also left, crushed but with nothing missing.

Timarcha tenebricosa (= *levigata*).

July 23-31, 1909. One offered to a Meerkat was eagerly seized, chewed up and swallowed without much hesitation. But while this Meerkat was just afterwards occupied with the *Carabus violaceus* (cf. *supra*, p. 837), he vomited the *Timarcha*. I do not know

whether the sickness was caused by the smell of the *Carabus*, which to me is nauseating, or to its taste, or by the irritation of the stomach caused by the *Timarcha*. I suspect the latter, because the Meerkat refused to touch a second *Timarcha* that was offered to him.

One smelt and rejected untasted by two more Meerkats; taken by a third in the same cage, rubbed in the sawdust, but left apparently uninjured.

One grabbed at once and eaten by White-tailed Mongoose, which immediately afterwards heaved and went through the action of vomiting without, however, ejecting the beetle. A second specimen was smelt and rejected with every show of disgust by the same animal, which persistently refused for the next two hours every beetle that was offered him, although before eating the *Timarcha* he had devoured a *Pterostichus madidus*. One rejected without being closely smelt by a Banded Mongoose which had eaten a *Coccinella 7-punctata*. Seized by a second Banded Mongoose, and eaten after a good deal of rubbing in the sawdust.

One offered to a Capuchin, one of the specimens which had refused the Telephorid (*Rhagonyche fulva*) (p. 840), was taken, smelt, and rejected.

One offered to another Capuchin was ultimately eaten piece-meal, but with so much delay caused by handling, licking, and inspection, that I am sure it was no great treat to him, especially as he had every reason to eat it speedily because a bigger Capuchin in the same cage, which had snatched the *Carabus* from his grasp, was almost continually after him to get the *Timarcha*. When monkeys like their food they gobble it up if there is the least likelihood of another taking it.

One offered to a Vervet Monkey was accepted, pulled to pieces and eaten, the exoskeleton being dropped to the ground.

This specimen of *Timarcha* had been previously offered to a Baboon (*Papio sphinx*); but he would not even touch it.

One put on the floor of aviary was pounced upon by Dial Bird, which after continued pecking and hammering could make nothing of it beyond breaking it in half at the waist. Ultimately he left it. An Orange-headed Thrush then tried the abdomen, but was driven off by a Hoopoe, which after pecking and hammering it, gave it up. The Thrush then tried again, and also gave it up. A Black-chinned Laughing Thrush then had a turn; but with the same result.

One given to Harmonious Shrike-Thrush which had eaten the *Coccinella*. He persevered for a long time, but could not manage it and flew away, leaving the beetle apparently unhurt. After about five minutes the bird came back and tried again, this time pecking off the legs and antennæ of the beetle; but he would not eat the body, and at last flew away and returned no more.

Sept. 18, 1910. One female taken by Kagu, well crushed, then swallowed at a gulp.

One male taken by Vigors's Bustard, crushed and put down with a head-shake; then tasted by two Ludwig's Bustards, the three birds having alternate pecks at it, the Vigors's Bustard finally swallowing it.

One female well tasted, but rejected by Wood-Swallow, Black-winged Grackle, Javan Pied Mynah, and Black-chinned Laughing Thrush: also by Sun-Bittern, which persevered for a long time, repeatedly washing the beetle in the water-trough, and taking a drink at the finish.

Taken and pecked to pieces, and eaten bit by bit by Silver Pheasant. The bird wiped his beak several times on the earth, and for some little time afterwards stood opening and shutting his beak like a monkey or a human being getting the flavour of something tasty.

Some of the birds which tried to eat the *Timarcha* showed no special signs of finding them unpalatable. It appeared to me that they finally refused them on account of the hardness of the exoskeleton. Probably this prevented them getting at the softer tissues containing the flavour, whether unpleasant or otherwise.

Larva of Timarcha tenebricosa.

(A fat bluish-black grub.)

June 15 to 24, 1909. One eaten with apparent relish by Meerkat, which only delayed seizing it for about two seconds to rub it in the sawdust and smell it. This was the same Meerkat that on a previous occasion had eaten *Euchelia jacobaeae* and rejected the *Coccinella*.

One taken at once by the same Capuchin that had eaten *E. jacobaeae* and rejected *Coccinella*: but after crushing it between his teeth and getting the flavour, the monkey at once took it out in his hands, contemplated it for a few seconds, and moving his lips the while as if sampling the flavour, then letting it fall, retired to the back of his cage, salivated and heaved twice as if going to vomit.

Another Capuchin in the same cage now picked up the crushed larva, tasted it, and put it down; and neither of the monkeys touched it again. So I gave it to the Meerkat, which ate it as greedily as it did the first.

One given to Armadillo was eaten after a good deal of smelling. A second was eaten without hesitation.

One given to Dent's Monkey was eagerly taken and tasted, but almost at once dropped. The monkey did not taste it again, although he was interested in it and played with it for some little time.

One given to Mona Monkey, which behaved in much the same way as Dent's Monkey, but played with the larva for a longer time.

One given to Capuchin (sp. *a*) was taken and chewed up, but

just as I thought he was going to swallow it, he spat it out with profuse salivation.

One given to another Capuchin (sp. *a*) was licked and dropped.

One given to a third Capuchin (sp. *b*) was chewed up and swallowed without any signs of dislike, the larva being not even taken from his mouth for examination.

Another given to the same monkey was also eaten without any signs of dislike, although he held it in his hands and licked it several times before finally putting it into his mouth and chewing it.

June 24, 1909. Repeated experiments with monkeys.

The two Capuchins (sp. *a*), the Dent's and Mona Monkeys behaved exactly as before. They took the larvæ, smelt them, tasted them once or twice, and finally rejected them. The Capuchin (sp. *b*) which had previously eaten two, again ate one without signs of relish or the opposite. I then offered a larva to another Capuchin of the same species (*b*) and he treated it as the specimens of the species *a* and as the Mona had done, that is to say smelt it, tasted it, rubbed it in his hands, repeated the tasting once or twice, and finally dropped it. His behaviour showed that the difference between the behaviour of the first example of sp. *b*, which ate the larvæ, and that of the examples of sp. *a*, which rejected them, is not attributable to the specific distinction between the Monkeys as might have been supposed, if only one specimen of sp. *b* had been available for experiment.

One given to Canadian Jay, taken, pecked, jammed into a cranny, and repeatedly pecked; then dropped. When the bird made no attempt to fetch it, the keeper picked it up and placed it on the perch, when the bird again seized it, jammed it into a cranny in the perch, and left it.

One given to Red-backed Shrike was eagerly seized, and after one or two pecks was left, the bird retiring and wiping his beak on the bars, as the Canadian Jay had also done.

Two given to Silver Pheasant were taken and pecked, and after a good deal of rubbing in the earth were eaten.

One given to Prince of Wales' Pheasant was taken, pecked and rejected.

One given to Piping Crow was pecked and tasted and rejected, after a good deal of shaking of the head and wiping of the beak on the part of the bird. It was then picked up by a Magpie, which after a taste or two stowed it away under a large stone, and built up the hole with pebbles.

One given to Buff Laughing Kingfisher was taken and tasted, but rejected with much bill wiping. Tried and rejected in the same way by a second specimen of this bird.

One given to Common Laughing Kingfisher was taken and tasted, but finally rejected.

One given to Dial Bird was finally rejected after a great deal of pecking and tasting, accompanied by much shaking of the head and wiping of the bill.

One given to White-collared Crow was taken, tasted, carried about, and finally dropped. This bird refused to take a second specimen offered immediately afterwards.

One given to Hooded Crow was treated in exactly the same way as the one above-mentioned was treated by the White-collared Crow. This Hooded Crow also refused a second specimen.

One given to Wild Turkey was taken and pecked, but soon rejected.

SEVEN-SPOTTED LADYBIRD (*Coccinella 7-punctata*).

July 5, 1909. I offered one to the Capuchin which was the only one of these Monkeys to eat the *Timarcha*-larvæ, thinking he might be deficient in tasting powers. He took it at once from my fingers into his mouth, and crushed it between his teeth; but, presumably as soon as he got the flavour, removed it from his tongue with his fingers, and took no further notice of it.

I offered the remains to a Mona Monkey, but she only smelt them and pulled them to pieces, and would not taste them.

July 23 to 31, 1909. One was offered the Capuchin (sp. a) that had eaten the *Euchelia jacobæ* and *Bombus lapidarius* on the previous day, and had so far refused nothing in the way of Lepidoptera. He took it from my hands directly, transferred it to his mouth and crushed it; but instantly took it from his tongue, wiped it on the perch and left it without a second look. I then gave the crushed insect to the Meerkat that had eaten *E. jacobæ* and the *Bombus lapidarius*. He seized it at once, but just as promptly spat it out, gave his mouth a wipe with his paw, and never attempted a second taste.

One given to Vervet Monkey which had just eaten a *Timarcha tenebricosa* (see p. 842). She took it, smelt, licked and examined it thoroughly, rubbed it between her hands, then dropped it to the floor and took no further notice of it. I had previously offered this *Coccinella* to a Chama Baboon. She smelt it but would not take it from my fingers.

One given to the Capuchin which on a previous occasion had tasted and rejected one. He took it, and after a great deal of smelling, tasting, rubbing between his hands and on the boards of the cage, finally ate it bit by bit, pulling it into many little pieces. This Capuchin had just before eaten a *Carabus violaceus*.

One smelt but refused by three Meerkats. Grabbed by Yellow Meerkat, tasted, but let go unhurt. Taken by Banded Mongoose, and eaten after much rubbing in the sawdust, and with many shakes of the head.

One offered to Grey Lemur, was smelt, taken in the hand and dropped.

Sept. 20, 1910. One taken and quickly eaten by Meerkat; but the same animal refused a second specimen.

One taken and rubbed about in the sand and repeatedly bitten,

and ultimately eaten by another Meerkat, but the same animal refused a second.

One taken in the paws by a Marsh Mongoose, but rejected after being repeatedly rubbed in the sand and smelt.

One taken by Banded Mongoose and crushed, but rejected with much head-shaking; swallowed by a second animal also with much head-shaking.

One refused after being smelt by three Yellow Meerkats.

One taken and licked by Capuchin, but rejected.

One licked but rejected by Red-handed Marmoset.

Another monkey of same species, and a Common Marmoset refused even to taste it.

July 23, 1909. One examined by Spectacled Thrush, but not touched. Pecked by Fantailed Flycatcher, which shook his head and left it. The bird returned three times, however, and pecked the beetle, but finally gave it up. I then offered it to a Shama three times in succession, and upon each occasion he flicked it away and made no attempt to follow it up. Next I tried the Harmonious Shrike-Thrush. He took it, and after a good deal of pecking, ate it.

July 31, 1909. Three eaten in succession by cock Silver Pheasant. The first one he took from my hand, but put it out of his beak on to the ground. After one or two pecks, however, he swallowed it. The others he took from my fingers and bolted entire as if they were grain, exactly as he had previously bolted the beetles, *Pterostichus niger* and *Ocyopus olens*.

Sept. 20, 1910. One taken by Pearl-spotted Owl, but dropped at once.

One taken by a Pekin Robin, which after a few pecks and head shakes left it and took a drink of water; tasted by another bird of the same kind, but also left uneaten.

One taken and swallowed, after a deal of pecking about in the sand and head shaking, by another specimen of Pekin Robin, which had just previously eaten the grasshopper (*Stenobothrus*) and the bug (*Therapha hyocyami*).

One given to the Dial Bird that had just eaten a Humble Bee (*Bombus agrorum*). He took it at once, and after a little delay swallowed it whole.

N.B. This is the bird that rejected the two White Butterflies (*Pieris brassicæ* and *napi*) after tasting them.

One taken but rejected by Masked Wood-Swallow; then taken and eaten by Shama.

Two taken and bolted quickly by the same Shama, which showed no signs of objecting to the taste, except a single shake of the head on each occasion after swallowing the beetle.

Although some of these beetles were eaten both by mammals and birds, there can be no doubt that they were distasteful to the majority of the animals to which they were offered, even to some of those that ate them.

The interest of the demonstration of the distastefulness of *Coccinella 7-punctata* lies in the fact that Coccinellidae of various kinds are mimicked in the tropics by insects of other orders, as well as by spiders.

Order **HEMIPTERA.**

OLIVE-BROWN BUG (*Tropicoris rufipes*).

July 21, 1909. One (dead) given to Mona Monkey was eaten after a great deal of handling, smelling and tasting.

One put on the ground was tackled by Fantailed Flycatcher, which pecked it some half dozen times. He was then driven off by a hen Black Tanager, which pecked it and pecked it again, and then left it. A Syrian Bulbul then flew up and tried it, but after persevering for some little time gave it up. Then the Tanager had another attempt, but left it. I then gave the mangled remains to the Harmonious Shrike-Thrush, and after a little pecking about he swallowed them.

One (living) eaten with very little delay by Silver Pheasant; but put on the ground after being taken from my hand. This specimen was immature on arrival; it moulted in the box, and was apparently adult when given to the bird.

One (dead) treated in the same way and eaten by the same bird.

RED AND BLACK BUG (*Therapha hyocyami*).

Sept. 20, 1910. One given to Pekin Robin was at once taken and ultimately eaten; but the bird took a long time over it, putting it on the ground after each peck and vigorously shaking his head before tasting it again. The behaviour of this bird was exactly the same towards *Coccinella 7-punctata* (p. 846).

Order **DIPTERA.**

Bombus-like Fly (*Volucella bombylans*).

July 26, 1909. One taken by Fantailed Flycatcher but after being pecked and pulled about for some time, was left. The Sulphury Tyrant then tried it, but also left it alone after much pecking. Finally it was taken by Spectacled Thrush, which ate it after much pecking and wiping in the sand.

One given to Black-headed Sibia was eaten after a great deal of pecking and breaking up.

These experiments, as Dr. Longstaff reminded me, suggest that this fly is, at all events to a certain extent, unpalatable. If future tests should prove it to be so, its likeness to *Bombus* will be an instance of Müllerian rather than of Batesian Mimicry.

See also below, pp. 854-855.

Bombus-like Fly (*Arctophila mussitans*).

See below, pp. 851 and 853.

Fly like a small Bombus (*Chilosia illustrata*).

See below, pp. 854-855.

SPINY FLY (*Echinomyia ferox*).

July 31, 1909. One (dead) taken by female Tanager, but after a good deal of pecking, was left. A Black-headed Sibia then tried it and finally ate it.

One also eaten by Sulphury Tyrant (see below, p. 855).

DADDY LONG-LEGS (*Tipula oleracea*).

Oct. 26, 1909. One taken from my hand and eaten readily by Dial Bird; one taken and eaten, but not so readily, by a second Dial Bird; one eaten greedily by Fantailed Flycatcher.

One of these specimens of *Tipula* was taken twice by the Harmonious Shrike-Thrush, but was dropped on both occasions. Another was taken three times by Black-winged Grackle, but was not eaten.

The rejection of this insect by the Shrike-Thrush, which ate almost every insect other birds refused, was very surprising.

Fly (*Empis tessellata*).

July 31, 1909. Two (dead). Eaten greedily by the Dent's Monkey that took the *Thanaos tages* with avidity (p. 831).

Order HYMENOPTERA.

Tipula-like Ichneumonid (*Ophion luteus*).

(Nocturnal species, mahogany-red in colour, with very tough integument.)

Oct. 26, 1909. One taken and tried perseveringly by Fantailed Flycatcher, but ultimately abandoned. Also tried but soon given up by Yellow-crowned Hangnest; taken and after a little pulling about swallowed entire by Dial Bird.

Nov. 7, 1909.—Taken by Black-winged Grackle; but so hard was the insect that it shot away out of his beak. The bird pounced on it at once on the sandy floor of the aviary and ate it; but if the insect had not been very lethargic, or if it had fallen amongst the undergrowth, it might have escaped him. Hence probably the significance of its hard slippery exoskeleton.

Larvæ of Saw-fly (*Cladius viminalis*).

These larvæ were yellow with black spots. They were sent to me by Mr. Taylor.

Aug. 19, 1910. Refused without tasting by Yellow-crowned Hangnest, Crested Bulbul, Blue-bird, and Fantailed Flycatcher.

Tasted but rejected by Black-winged Grackle, Harmonious Shrike-Thrush, Black-chinned Laughing Thrush, and Green Toucanet.

Taken by Greater Spotted Woodpecker, placed in a hole in a stump and hammered, but ultimately flicked away and lost.

Two taken and eaten after much pecking and tasting by a Shama. One eaten fairly readily by a Dial Bird; but another bird of the same species rejected a specimen after tasting and flicking it from his beak about twenty times.

WOOD-ANT (*Formica rufa*).

May, 1910. Taken and eaten with avidity by the following birds:—Pearl-spotted Owl; Orange-headed Ground-Thrush; Dial Bird; Shama; Black-headed Sibia; Blue-bird; Pekin Robin; Harmonious Shrike-Thrush; Spotted Oriole; Larger Hill Mynah; Black-winged Grackle; Yellow-crowned Hangnest; Greater Spotted Woodpecker.

A Capuchin Monkey also ate one after another, picking them up in his hands and gobbling them as fast as possible.

Several specimens thrown into a cage containing three Wall Lizards were tasted by two of them, but rejected at once without being damaged in any way by the tasting.

Most of the birds showed no signs of objecting to the taste of the ants, or even of perceiving anything peculiar in their flavour. The Pearl-spotted Owl, however, shook his head, and the Spotted Oriole wiped his beak on the perch after eating them. The Pekin Robin and the Black-winged Grackle wiped the ants upon their wings, presumably to remove the formic acid. It is interesting to find the same device practised by two species so unlike one another.

I found that the birds, like the monkey, would eat as many of these ants as were given to them.

The unavoidable conclusion that these insects are palatable is rather surprising in view of the frequency with which ants of different kinds are mimicked in the tropics by Orthoptera, Coleoptera, and other insects, as well as by spiders. Nevertheless, it corroborates the opinion put forward by McCook and amplified and endorsed by myself in 1909*, before these experiments were made, that ant-mimicry is mainly serviceable as a protection against the predatory Hymenoptera of the family Pompilidæ, which provision their nests with Arthropoda of various kinds, excepting ants, and are certainly the direst enemies that spiders possess.

* Journ. Linn. Soc., Zool. xxx. pp. 265-268.

SAW-FLY (*Allantus arenatus*).

July 21, 1909. One eaten by Mona Monkey fairly readily; by Capuchins readily; by the Capuchin which on the previous day had refused the Malacoderm Beetle (*Rhagonyche fulva*); smelt, but not tasted by Lion Marmoset.

One eaten fairly readily by Harmonious Shrike-Thrush; by Shama readily; by Silver Pheasant; refused without tasting by Wild Turkey.

HONEY-BEE (*Apis mellifica*). (Workers.)

May 8, 1911. One offered to Silver Pheasant was taken from the forceps but immediately flicked away; the bird persevered, however, and after much pecking and flicking about of the insect, and wiping his bill on the ground, finally ate it.

One offered to Bornean Fire-backed Pheasant was inspected carefully but rejected untasted.

One given to Pekin Robin was taken at once, but was quickly flicked away. When pursued, however, by other birds in the cage, the Pekin Robin pounced on the bee again and flew away with it. Whenever he got a moment's peace, he put it on the ground, pecked and flicked it about, wiping it now and again in the sand and repeatedly shaking his head. At length he flew to a branch, and holding the bee against it with his foot, pulled it in two pieces, dropping one piece to the ground. He still persevered with the other piece, however, but I finally lost sight of him and do not know whether he ate it or not.

One given to a Cayenne Tanager was taken and chewed for a long time; the remains, however, were finally jammed into a banana and left.

One taken by a Blue Tanager which, however, allowed himself to be robbed without resistance or flight by a Maroon Tanager. This bird, after a deal of mastication, ate the bee.

One given to Wall Lizard was eagerly seized, but was left after one or two attempts.

Another was twice darted at by another lizard of this species, but was left alone the moment the lizard touched it. It was then boldly seized by a third lizard, which with one bite disabled the bee by crushing the head and thorax. This lizard persevered for about seven minutes, biting at the bee, but stopping after each bite to lick his mouth with his tongue and rub it against the moss. Finally he gave it up and went away.

Two Bluebottles (*Calliphora vomitoria*) and a Hover-fly (*Syrphus*) given as a check experiment were seized and eaten in a few seconds by the same lizards.

HUMBLE BEE (*Bombus agrorum*).

(See also *infra*, p. 853.)

Oct. 26, 1909. One eaten with avidity by Capuchin and by Meerkat.

One given to Collared Jay-Thrush, which pecked it about and scraped it in the sand for a long time, wiping his beak in the intervals, and ultimately left it. It was then picked up by a White-crested Jay-Thrush, which treated it for some time in the same way, but at last ate the mangled remains. This same bird then took a specimen of the mimetic fly *Arctophila mussitans*, but made just the same fuss over the eating of it as he had in the case of the bee.

Sept. 18, 1910. One taken at once by Dial Bird, and after a good deal of pulling about, pecking and wiping in the sand, was eaten. This bird had just previously eaten a small Tortoiseshell Butterfly, and he took about the same time to finish off the one insect as the other.

Sept. 20, 1910. One offered to Dial Bird was taken at once and eaten with very little delay, after being wiped once or twice in the sand. The bird flew away with a second specimen and I did not see what became of it; but he returned to me, and I had difficulty in keeping him away from the bees with which I was experimenting with other birds.

This Dial Bird was the one that ate the same species of Humble Bee two days previously.

HUMBLE BEE (*Bombus* ? *joncellus*).

July 31, 1909. One offered alive to Mona Monkey was snatched at once and eaten bit by bit.

HUMBLE BEE (*Bombus* ? *terrestris*).

July 31, 1909. One (dead) taken by Brazilian Hangnest and pecked to pieces, the bird holding it the while in his foot against the perch. The pieces pecked off were dropped about the cage and not eaten.

HUMBLE BEE (*Bombus lapidarius*).

May 31, 1909. One dead specimen given to the Meerkat was eaten bit by bit, after being rubbed in the sawdust by the animal's paws.

One dead specimen given to Capuchin (*Cebus* sp. *a*) was taken in the hands and eaten bit by bit, just as the Monkey would eat a piece of hard biscuit or sugar. Neither of these mammals showed any signs of disliking the taste of the bees; quite the contrary. Their molar teeth are evidently much better adapted for crushing the chitinous exoskeletons than are the beaks of the birds that tasted them.

One dead specimen offered to Syrian Bulbul was taken after about a minute's inspection. The bird pecked it and pulled it about for at least five minutes and dodged away with it from other birds that chased him. He grew, however, less and less

keen, and ultimately allowed a female Black Tanager to rob him of it. The Tanager behaved in just the same way, pecking and pulling it about and breaking it to pieces, but gradually losing her interest. At last she picked up a piece of the thorax and flew to a bush with it, leaving the remainder on the ground. I could not see what became of the piece she flew away with, but she emerged from the bush without it, and wiped her beak on a perch. She made no attempt to go back to the bits on the ground. A Sibia tried these, but after a peck or two left them, and no other insectivorous bird in that compartment took the least notice of them. So I picked up the abdomen and gave it to the Harmonious Shrike-Thrush which had just finished off the example of *B. hortorum*, mentioned below, and he ultimately ate it after a great deal of pecking and pulling about.

HUMBLE BEE (*Bombus hortorum*).

May 31, 1909. One living example fell to the ground of the aviary when first liberated. Two Fantailed Flycatchers flew down to it at once, but although interested would not touch it; while they were hesitating the bee took wing and escaped, none of the birds in the aviary making any attempt at pursuit.

One dead specimen offered to a Shama. She allowed me to hold it close to her beak, but would not touch it. None of the other birds in the aviary would notice it when thrown to the ground, though on a previous occasion they had shown great eagerness in seizing dead butterflies. I then gave it through the bars to the Harmonious Shrike-Thrush in the next compartment. After pecking and pulling it about for six or seven minutes, he ultimately ate it.

July 31, 1909. One sniffed at but rejected by two Meerkats; taken by a third and eaten.

One pecked and flicked away by Black-headed Sibia, by Shama and also by Sun-Bittern, each making two or three attempts. Then carried off by female Black Tanager, but dropped to the floor, where a North American Cat-bird tried it once or twice, but gave it up. (The remains were now too mangled to be useful for further experiment.)

I could not induce the Fantailed Flycatcher to take any notice of this bee.

Conclusion. These experiments indicate that the Humble Bees used for the tests were much more palatable to the mammals than to the birds. With the exception of the one example of *B. lapidarius* which was smelt and left untouched by two Meerkats, all the bees offered to the Monkeys and Meerkats were eaten without any kind of dislike of the flavour being evinced. The Meerkat that rubbed the *B. lapidarius* in the sawdust did so, I suspect, to remove some substance offensive to his sense of smell. On the other hand, of the birds to which the bees were offered only three

ate them, namely a Dial Bird, a Jay-Thrush, and a Shrike-Thrush. The Dial Bird ate one quickly with only one or two wipes in the sand. In the other cases there was a great deal of pecking and wiping before the insects were finally disposed of. From the behaviour of the birds there could be no doubt that there was something in the bees not to their liking, even to those that ultimately ate them. The Bulbul, Sibia, and Tanager were obviously keen to eat them, and gave them the fullest possible trial before finally rejecting them; but whether it was the hairs, or the hard chitin, or the flavour, or a combination of them that made the insects unpalatable, I do not know.

Further experiments demonstrating the distastefulness of Humble Bees to birds of different kinds are given in the following section:—

Experiments to test the significance of the resemblance between Humble Bees (*Bombus*) and the Flies *Arctophila mussitans*, *Volucella bombylans*, and *Chilosia illustrata*.

Bombus agrorum and *Arctophila mussitans*.

Oct. 26, 1909. Offered Bee to a Lion Marmoset which was busily catching house-flies and bluebottles in his cage. He looked at it, but would not touch it. I then offered the fly, but he also refused to touch it. He did not, however, hesitate to take a Red Admiral offered a moment afterwards.

Offered Bee to Leach's Laughing Kingfisher. He took it at once, but soon flicked it away. Six times in succession he took it from my fingers and dropped it on each occasion. I could not induce him to take it again. Instead he started pecking my fingers. Thereupon I offered him the fly, and he just as resolutely refused to take it.

Offered Bee to Kagu, a New Caledonian Rail. He inspected it, and after a little hesitation tasted it. But he would not touch it again; and when offered the fly, refused that likewise.

Offered Bee to Central American White-browed Partridge. He took it without hesitation, but after a peck or two left it and went away. I then threw it to him, and he tasted it again; but would not eat it. I then threw him the fly, but he would not touch it.

A Douracouli (a South-American monkey); a Honduras Turkey; a cock and a hen Reeves's Pheasant, and three hen Silver Pheasants refused to touch both bee and fly, though they inspected them intently for a few seconds.

Sept. 20, 1910. Bee offered to Hoopoe was taken at once and tasted without being crushed, but was then left on the ground uneaten. The bird refused the next one I offered, and then refused to take the fly, although he stretched his head towards it and inspected it.

Bee offered to Yellow-crowned Hangnest, which took it at once, but soon dropped it. A second time he took it, and dropped it.

The third time it was offered he refused it, and immediately afterwards refused the fly.

Bee offered to Sulphury Tyrant. I importuned the bird into taking it from my fingers no fewer than eight times, and each time he flicked it away. The ninth time he refused to take it, and then refused the fly.

Bee offered to Black-winged Grackle, which took it at once, but dropped it. Twice more he took it and the last time flew a short distance away and persevered with it for about three-quarters of a minute, then leaving it returned to me; he refused the next bee I offered, and then refused the fly.

Bee offered to Silver Pheasant was at once taken, put on the ground, pecked and crushed almost past recognition, but left uneaten. The bird then took from my fingers three more specimens in succession, but dropped them uncrushed from his beak at once. The fifth he looked at, but would not touch, and then also refused the fly after inspecting it.

The experiments described above with the Lion Marmoset, the Douracouli, the Turkey, and the Reeves's and Silver Pheasants, which would not touch either the bee or the fly after some seconds of intent inspection, do not prove that the bee was known to be distasteful, and that the fly was rejected in consequence. That may be the explanation. The Douracouli, however, is nocturnal and probably does not naturally feed upon diurnal-flying insects. In the case of the Marmoset, the experiment does, however, suggest very forcibly that the *Arctophila* was not recognised as closely allied to the bluebottles the animal was hunting. The other experiments speak for themselves.

Bombus hortorum, *Volucella bombylans*, and
Chilosia illustrata.

July 31, 1909. Offered living *Bombus hortorum* to the Brazilian Hangnest that had just pulled the dead *Bombus terrestris* to pieces. He took it directly, but instantly flicked it away and wiped his beak. The bee then crawled up the bars of the cage, and he again pecked and flicked it away. It was now too injured to crawl although still alive, so I picked it up and offered it in my fingers. He took it again and flicked it away. Twice more the trial was made, with the same result, although he was patently tiring of the trials. The next time he refused to touch it after inspection. I then substituted a dead *Volucella bombylans*. He inspected it, but did not touch it, and hopped up to the top perch.

I then offered the nearly dead *Bombus* to another specimen of the same bird. He took it from my fingers three times in succession, and each time flicked it away. The fourth time he refused to touch it. I then substituted the same specimen of *Volucella bombylans*, but after looking at it he would not take it.

I then again offered the *Bombus* to the first Hangnest. He took it and flicked it away, and immediately afterwards refused to touch the *Volucella*.

Next day I offered the first Hangnest a *Bombus* again; he took it from me three times, and flicked it away without attempting to eat it, but immediately afterwards took *Chilosia illustrata* and ate it.

The second Hangnest took a dead *Bombus*, and flicked it away, and then ate *Chilosia illustrata*, but refused immediately afterwards to touch a live *Bombus hortorum*.

Offered *Bombus hortorum* to North American Cat-bird, which came up to me on seeing other birds being fed. He pecked it several times, but flicked it away and gave it up. During the next quarter of an hour I could not induce him to touch either *Volucella bombylans* or *Chilosia illustrata*.

I then offered the *Bombus* on the forceps to a Sulphury Tyrant. He pecked and flicked it away several times, then left it, and refused it when offered again. I then offered him the *Volucella bombylans* both in the forceps and by throwing it to him on the ground, but he would not touch it. After a little hesitation, however, he took an *Echinomyia ferox* from the forceps and ate it, and then took and ate *Chilosia illustrata*. I then offered him *Bombus hortorum* again, and he took it but soon rejected it, and immediately afterwards refused to touch *Volucella bombylans*.

One *Bombus hortorum* offered to a Shama, which pecked it once or twice, and flicked it away each time. He then refused to touch the specimen of *Volucella bombylans*.

Tried the experiment with another Shama, which behaved in exactly the same way towards the bee, and would not afterwards touch the *Volucella bombylans*.

One *Bombus hortorum* offered to Silver Pheasant was taken at once, but left after some pecking and tasting. Then without hesitation he took *Chilosia illustrata* from the forceps and ate it; and promptly tried the *Bombus* again as it lay on the ground, but would not eat it. Immediately afterwards he eagerly ate an *Ocypus olens* and three specimens of *Pterostichus* (see pp. 837-838).

I made one *Volucella bombylans* do duty for all the experiments described above and had it intact at the end. It was not pecked by any of the birds, presumably because I never offered it to one until he had tried *Bombus hortorum* a sufficient number of times to reject it as unpalatable; and there is no doubt in my opinion that they did not distinguish between the bee and the fly. Although *Chilosia illustrata* is also very like *Bombus*, the difference in size is well marked. I suspect that in this circumstance lies the explanation of the birds not confusing this species of fly with the bee. They could judge the difference in size quite easily, because the insects were held at the same distance from them.

LIST OF THE MAMMALS, BIRDS, AND REPTILES USED FOR THE
EXPERIMENTS.

MAMMALS.

Mona Monkey (*Cercopithecus mona*), Nigeria. Diana Monkey (*Cercopithecus roloway*), Gold Coast and Guinea. Dent's Monkey (*Cercopithecus denti*), Ituri Forest. Vervet Monkey (*Cercopithecus pygerythrus*), Cape Colony. Yellow Baboon (*Papio sphinx*), Nigeria. Ceylonese Macaque (*Macacus pileatus*), Ceylon.

Although feeding mostly upon fruits, roots, and vegetables of various kinds, all the Monkeys of the Old World eat insects as well.

Capuchins (*Cebus*, spp.?).

Several immature specimens, belonging to undetermined species inhabiting the forests of the northern parts of South America.

Douracouli (*Nyctipithecus trivirgatus*).

A nocturnal Monkey from the Amazons.

Lion Marmoset (*Leontocebus rosalia*). Pinché Marmoset (*Leontocebus ædipus*). Red-handed Marmoset (*Leontocebus rufimanus*). Common Marmoset (*Callithrix jacchus*).

Although vegetable feeders in the main, the South American Monkeys and Marmosets seem more addicted to an insect diet than the Monkeys of the Old World.

Grey Lemur (*Hapalemur griseus*). Crowned Lemur (*Lemur coronatus*). Black Lemur (*Lemur macaco*). White-fronted Lemur (*Lemur fulvus albifrons*). Mongoose Lemur (*Lemur mongoz*).

Lemurs inhabit Madagascar. They do not appear to be partial to insects.

Suricate or Meerkat (*Suricata suricatta*).

Cape Colony. Feeds on small animals of various kinds and particularly insects and their grubs (*W. L. Slater*).

Yellow Meerkat (*Cynictis penicillata*).

Cape Colony. Feeds on small birds, mammals, eggs, and insects (*W. L. Slater*).

Banded Mongoose (*Crossarchus fasciatus*).

South and East Africa. Feeds on insects, fruits, seeds, eggs, snails, etc., according to Böhm.

Common Indian Mongoose (*Mungos mungo*), from India, and McCarthy's Mongoose (*Mungos fulvescens*), from Ceylon, live on small mammals, birds, reptiles, insects, and fruit. The White-tailed Mongoose (*Mungos albicauda*), from Africa south of the

Sahara, does not, so far as is known, differ in diet from the other species just mentioned.

Marsh Mongoose (*Mungos galera*).

West and South Africa. An amphibious species feeding mainly it is alleged upon crabs, fishes, frogs, and insects.

Grison (*Grison furax* = *Galictis vittata*).

A musteline carnivore from the Argentine, feeding upon small mammals and birds but also fond of fruit.

Common Armadillo (*Dasypus villosus*).

Argentine. Feeds on insects, grubs, worms, carrion, and vegetable matter.

BIRDS.

Cape Robin-chat (*Cossypha caffra*).

Range. East Africa to Cape Colony.

Food. Chiefly insects, spiders, and worms; also berries and small fruit (*Sclater & Stark*).

Common Thrush (*Turdus musicus*).

Range. Palearctic Region, locally migratory.

Food. Insects, worms, fruit, etc.

Orange-headed Ground-Thrush (*Geocichla citrina*).

Range. The Himalayas up to 5000-6000 ft., Assam and Tenasserim.

Blue Rock-Thrush (*Geocichla (Monticola) cyanus*).

Range. From South Europe and North Africa to Turkestan, Tibet, the Himalayas, and Burma.

Common Rock-Thrush (*Geocichla (Monticola) saxatilis*).

Range. C. & S. Europe to C. Asia, N.E. Siberia and N. China.

Wood-Thrush (*Hylocichla mustelina*).

Range. Eastern North America, Central America to Guatemala.

Dial Bird (*Copsychus saularis*).

Range. Ceylon, India, ascending the Himalayas up to 5000 ft.; Burma and Tenasserim.

Shama (*Cittocincla macrura*).

Range. Ceylon, India and Burma.

Blue-bird (*Sialia sialis*).

Range. Eastern North America to a little west of the Missouri River.

Food. Insects of various kinds; also ripe fruits.

American Cat-bird (*Galeoscoptes carolinensis*).

Range. South-eastern United States to the Missouri, migrating southwards in the winter.

Food. Insects, fruit and seeds.

Mocking Bird (*Mimus polyglottus*).

Range. Southern United States from the Atlantic to the high central plains ; locally migratory.

Food. Insects and fruit.

Cuban Mocking Bird (*Mimus orpheus*).

Range. Jamaica, Porto Rico, Haiti, Cuba.

Saturnine Mocking Bird (*Mimus saturninus*).

Range. Brazil.

Great Tit (*Parus major*).

Range. Widely distributed in the Palearctic Region. Locally migrating but mostly resident.

Food. Insects and seeds.

Pekin Robin (*Liothrix luteus*).

Range. Himalayas from Simla to Bhutan ; extending also into China ; resident.

According to E. W. Oates the food of this bird consists of berries, fruit, seeds, and insects.

Pied Grallina (*Grallina australis*).

Range. Australia, generally distributed.

Food. Insects (Gould).

White-eared Bulbul (*Pycnonotus leuconotus*).

Range. Persia ; Sind, the Punjab, the N.W. Provinces of India, and Central India as far east as Hoshargabad.

White-cheeked Bulbul (*Pycnonotus leucogenys*).

Range. Afghanistan ; the Himalayas from Muree to Bhutan, up to 7000 ft.

Red-vented Bulbul (*Pycnonotus hæmorrhous*).

Range. Ceylon ; India roughly to the foot of the Himalayas.

According to E. W. Oates the Indian species of Bulbuls feed chiefly upon fruit.

Syrian Bulbul (*Pycnonotus xanthopygus*).

Range. N.E. Africa, Arabia, Palestine, Cyprus.

Black-crested Bulbul (*Otocompsa flaviventris*).

Range. Nepal to Cochin China.

In the course of my experiments I noticed that Bulbuls of different species were very keen on butterflies ; of beetles and crawling insects generally they took little if any notice ; but the moment a butterfly was let loose in the aviary they were all on the move. From this I infer that they are great butterfly-hunters in their own countries.

Orange-headed Laughing Thrush (*Trochalopteron erythrocephalum*).

Range. Himalayas, from Chamba to Nepal up to 7000 ft.

Black-chinned Laughing Thrush (*Trochalopteron nigrimentum*).

Range. Himalayas from Nepal to Assam (7000 ft.).

According to E. W. Oates the food of the Laughing Thrushes (*Trochalopteron*) is the same as that of the Jay-Thrushes (*Garrulax*).

Spectacled or Melodious Jay-Thrush (*Trochalopteron canorum*).

Range. China; Shanghai, Amoy, Fokien, Chekiang.

Black-headed Sibia (*Sibia capistrata*).

Range. Himalayas from Hazára to Bhutan, 5000-8000 ft.; resident.

Collared Jay-Thrush (*Garrulax picticollis*).

Range. China: Chekiang, Fokien.

White-crested Jay-Thrush (*Garrulax leucolophus*).

Range. Himalayas to Assam and Burma in the hill-tracts.

According to E. W. Oates the Indian species of *Garrulax* feed upon every sort of insect and smaller reptiles, and probably also on fruit.

Grey Struthidea (*Struthidea cinerea*).

Range. South-eastern Australia; resident.

Food. Insects, particularly beetles.

Spotted Oriole (*Oriolus maculatus*).

Range. Sumatra, Java, Borneo.

Harmonious Shrike-Thrush (*Collyriocincla harmonica*).

Range. Australia; N. S. Wales and S. Australia.

Food. Insects (*Gould*).

White-eyebrowed Wood-Swallow (*Artamus superciliosus*).

Range. Interior of South Australia.

Food. Insects (*Gould*).

Masked Wood-Swallow (*Artamus personatus*).

Range. South Australia, locally migratory.

Food. Insects (*Gould*).

Red-backed Shrike (*Lanius collurio*).

Range. Europe, migrating in the autumn and winter into Western India and to South Africa.

Food. Insects; small birds etc.

Fantailed Flycatcher (*Rhipidura tricolor*).

Range. Australia, widely distributed.

Food. Insects of various kinds (*Gould*).

Garrulous Honey-eater (*Myzantha garrula*).

Range. South Australia, Tasmania.

Food. Honey and insects (*Gould*).

Black Tanager (*Tachyphonus melaleucus*).

Range. Costa Rica through Panama, Venezuela, Ecuador to Bahía.

Scarlet Tanager (*Rhamphocelus brasilius*).

Range. South-eastern Brazil.

Cayenne Tanager (*Calliste cayana*).

Range. Guiana, Venezuela, Ecuador, Peru.

Green Hangnest (*Ostinops viridis*).

Range. Guiana, Brazil, Ecuador.

Yellow Hangnest (*Cassicus persicus*).

Range. Trinidad, Guiana, Ecuador, Bolivia, Brazil.

Common Hangnest (*Icterus vulgaris*).

Range. Colombia, Venezuela.

Brazilian Hangnest (*Icterus jamaicai*).

Range. North Brazil.

Yellow-crowned Hangnest (*Icterus chryscephalus*).

Range. Guiana, Venezuela, Ecuador, Brazil.

Larger Hill Mynah (*Gracula intermedia*).

Range. India: the south-eastern Central Provinces, the lower ranges of the Himalayas from Kumaon to Assam, thence into the Malay Peninsula.

Small Hill Mynah (*Gracula religiosa*).

Range. Ceylon and Southern India.

According to E. W. Oates these two species of Mynah are resident or only locally migratory and live exclusively upon fruit.

Chinese Mynah (*Acridotheres cristatellus*).

Range. China: Shanghai, Hainan, Formosa; Philippine Islands.

Pied Mynah (*Sturnopastor contra*).

Range. Central and South India to Assam and Burma.

Javan Pied Mynah (*Sturnopastor jallæ*).

Range. Sumatra, Java, Borneo.

Black-winged Grackle (*Graculipica melanoptera*).

Range. Java.

Spotted Bower Bird (*Chlamydodera maculata*).*Range.* New South Wales.*Food.* Principally fruit and grain (*Gould*).King Bird of Paradise (*Cicinnurus regius*).*Range.* New Guinea.*Food.* Fruit and insects.Canadian Jay (*Perisoreus canadensis*).*Range.* Canada and the Northern States of the Union.*Food.* Insects ; eggs, flesh ; leaves of fir trees (*Audubon*).Hooded Crow (*Corvus cornix*).*Range.* Palearctic Region.*Food.* Omnivorous (eggs, carrion, young birds, etc.).White-collared or Pied Crow (*Corvus scapularis*).*Range.* Africa south of the Sahara.*Food.* Omnivorous, with partiality for flesh food.White-backed Piping Crow (*Gymnorhina leuconota*).*Range.* S. Australia, New South Wales.*Food.* Mostly insects (*Gould*).Long-billed Butcher Crow (*Cracticus destructor*).*Range.* Australia.*Food.* Chiefly insects.Sulphury Tyrant (*Pitangus sulphuratus*).*Range.* Guiana, Ecuador, Peru, Brazil.*Food.* Mostly insects and animal food of various kinds as well as fruit.Greater Spotted Woodpecker (*Dendrocopus major*).*Range.* Palearctic Region.*Food.* Insects.Common Laughing Kingfisher (*Dacelo gigantea*).*Range.* New South Wales and South Australia.Leach's Laughing Kingfisher (*Dacelo leachii*).*Range.* North-east coast of Australia.Buff Laughing Kingfisher (*Dacelo cervina*).*Range.* East and North Australia.*Food.* These great Kingfishers feed mainly upon reptiles and insects, but also upon rats and mice.Elate Hornbill (*Ceratogymna elata*) andBlack Hornbill (*C. atrata*).*Range.* W. Africa, Nigeria, etc.*Food.* Insects ; snakes, small mammals, etc.

Ground Hornbill (*Bucorax abyssinicus*).

Range. North Africa south of the Sahara.

Food. Insects, snakes, frogs, lizards (Stark and Selater writing of the closely allied southern species *B. caffer*).

Hoopoe (*Upupa epops*).

Range. Southern Palearctic Region from Scandinavia and the British Islands to Japan, migrating in winter to North Africa, Arabia and India.

Food. Ground insects, beetles, grasshoppers and ants.

Cartagenian Motmot (*Momotus subrufescens*).

Range. From Panama, Colombia, and Venezuela to Matto Grosso.

Great Barbet (*Megalæma virens*).

Range. China and Upper Burma.

Levaillant's Barbet (*Trachyphonus caffer*).

Range. S. Africa, Natal, the Transvaal, Rhodesia, etc.

Food. Fruits, berries, leaves, and insects such as termites (Stark & Selater).

Green Toucanet (*Aulacorhamphus sulcatus*).

Range. Venezuela; Colombia.

Pearl-spotted Owl (*Glaucidium perlatum*).

Range. Africa south of the Sahara.

Food. Mostly insects (grasshoppers, termites); also mice and lizards (W. L. Selater).

White-eared Scops Owl (*Scops leucotis*).

Range. Africa south of the Sahara to the Orange River.

Food. Chiefly insects, like grasshoppers; also rats and mice (W. L. Selater).

Prince of Wales Pheasant (*Phasianus principalis*).

Range. North-western Afghanistan and North-east Persia.

Reeves's Pheasant (*Phasianus reevesii*).

Range. Mountains of Northern and Western China, extending as far east as Kiu-Kiang.

Elliot's Pheasant (*Calophasis ellioti*).

Range. Mountains of South-eastern China.

Silver Pheasant (*Gennæus nycthemerus*).

Range. South China, Fokien and Chekiang.

Vulturine Guinea Fowl (*Acryllium vulturinum*).

Range. East Africa from the Pangani River westwards to Kilimanjaro and northwards to Somaliland.

Pucheran's Guinea Fowl (*Guttera pucherani*).

Range. East Africa : Zanzibar to the Tana River and thence westwards into the interior.

N. American Wild Turkey (*Meleagris americana*).

Range. Formerly widely distributed in the United States of America. Not migratory.

Food. Beechnuts, acorns, berries, green-shoots, etc. ; also grass-hoppers, and other insects (*Bendire*).

Honduras Turkey (*Meleagris ocellata*).

Range. Central America : Guatemala, Yucatan, Honduras.

Food. Probably of a similar nature to that of *M. americana*.

Long-tailed Partridge (*Dendrotyx leucophrys*).

Range. Highlands of Guatemala and Costa Rica (*Ogilvie-Grant*).

Brush Turkey (*Catheturus lathamii*).

Range. North-east and East Australia.

Crested Curassow (*Crax alector*).

Range. Northern part of South America : British Guiana, Colombia, Rio Negro, etc.

Globose Curassow (*Crax globicera*).

Range. Central America : Western Mexico to Honduras and Cozumel Island.

Yarrell's Curassow (*Crax carunculata*).

Range. South-eastern Brazil from Rio Janeiro to Bahia.

Red-tailed Guan (*Ortalis ruficauda*).

Range. Venezuela and the island of Tobago.

Most Game-birds, especially when young, eat insects as well as grain, nuts, and green-food.

Australian Bustard (*Eupodotis australis*).

Range. South and Western Australia.

Food. Seeds, vegetables, grasses, and insects (*Gould*).

Vigors's Bustard (*Otis vigorsii*).

Range. S. Africa : Cape Colony, Natal, etc.

Food. Seeds, insects, small reptiles (*Stark & Sclater*).

Ludwig's Bustard (*Otis ludwigi*).

Range. S. Africa : Cape Colony, Natal, Orange River Colony, S. Transvaal ; partially migratory within this area.

Food. Mostly beetles, caterpillars, and other insects (*Stark & Sclater*).

The food of Bustards is probably much the same everywhere. The diet is essentially mixed, and consists of grain, green-shoots and leaves insects, small mammals (mice) and reptiles.

Two-striped Thickknee (*Ædicnemus bistriatus*).

Range. Mexico through Central America to Venezuela

Food. Insects, worms, snails, etc.

Trumpeter (*Psophia crepitans*).

Range. Brazil.

Food. Fruits, seeds, insects.

Cariama or Seriema (*Cariama cristata*).

Range. South-east Brazil.

Food. Reptiles and small mammals for the most part.

Abbott's Rail (*Rallus abbotti*).

Range. Assumption Island.

Black-tailed Water-hen (*Tribonyx ventralis*).

Range. Australia, south of the 25th parallel; locally migratory.

Kagu (*Rhinochætus jubatus*).

Range. New Caledonia.

Sun-Bittern (*Eurypyga helias*).

Range. Northern countries of the Neotropical Region.

Food. Mostly insects.

REPTILIA

The Green Lizard (*Lacerta viridis*), from Central and Southern Europe; the Wall Lizard (*Lacerta muralis*), from Central and Southern Europe; the Filfolia Wall Lizard (*L. muralis filfolensis*), from Filfolia, near Malta; Dugès's Lizard (*Lacerta dugesii*), from Madeira; the Sand Lizard (*Lacerta agilis*), from North and Central Europe; and the Black-spotted Lizard (*Algiroides nigropunctatus*), from Dalmatia, feed mainly upon insects, worms, and small slugs.

Glass Snake (*Ophisaurus apus*).

South-eastern Europe. Feeds on small mammals, reptiles, slugs, etc.

Notes upon some of the above described Experiments by

Prof. E. B. POULTON, F.R.S., F.Z.S.

Pages 815-820.

The experiments on the *Pierinæ* support the conclusion that the perfection of the under surface procryptic resemblance affords a true criterion of the degree of palatability.

P. brassicæ, with its conspicuous gregarious larva, and imago larger and less cryptically coloured than the other three species

(although nearly the same as *P. rapæ* in this respect), was distinctly the least palatable of the four. On the other hand, *P. napi* and *E. cardamines*, in which the cryptic resemblance is carried to its highest pitch, appeared to be most palatable; but a larger number of experiments is greatly to be desired.

The results obtained in the two former species are of much interest in relation to the experiments upon *Melanargia galathea* (p. 827).

Pages 820-822.

The evidence that *V. urticae* is not very palatable agrees with my own experiments* with a Marmoset; and I obtained the same results with *V. io* when offered in considerable numbers to lizards. It is probable that the procryptic under surface of the *Vanessas* is chiefly related to the attacks of mammals and of very hungry birds during the long hibernating period. The special interest in the eye-spots of *V. io* manifested by the Syrian Bulbul, accords with previous observations on other insects and other insect-eaters, Reptilian as well as Avian†.

Pages 823-825.

The evidence of a certain amount of unpalatability in *Brenthis* (Argynnidæ) is consistent with the degree of procryptic defence attained in this genus. It is also of much interest in connexion with the experiments on *Araschnia levana*, the early or *levana* form of which is probably a mimic of the species of *Brenthis*. The examples of the *Araschnia* tested by the author (pp. 823-824) were of the form *prorsa*, belonging to the later brood, and generally looked upon as mimics of the White Admiral (*Limenitis sibylla*), which appears upon the wing at about the same period. The experiments here recorded prove that the mimic is certainly unpalatable to several birds, and support the conclusion that the resemblance is Müllerian or Synaposematic. The evidence, so far as it goes, points indeed to the inference that *Araschnia* is more unpalatable than its *Brenthis* model. A few experiments on the imago of *L. sibylla* made by Mr. Pocock in the summer of 1910, also indicated that the *prorsa* form is more unpalatable than the *Limenitis*. There is, however, nothing improbable in a Müllerian mimic being more highly protected than its model. The rôle of model is related to many characteristics, and relative abundance, conspicuousness, and extent of range may play their part as well as relative unpalatability. Thus it is probable, from its habits and flight, that the Eastern European *Neptis lucilla*, W.V. (= *sappho* Pall.) is more distasteful than its *Limenitis* models, but the latter are widespread and abundant species, and it is reasonable to suppose that the memories of European insect-eating animals are more deeply impressed by their pattern than by that of the *Neptis*.

* Trans. Ent. Soc. Lond. 1902, p. 442.

† 'Essays on Evolution' (Poulton), 1908, p. 210: see also p. 326.

Pages 825-827.

The desirability of experiments upon the palatability of the genus *Melitæa* was suggested by the study in 1908 of a collection of butterflies from the Tian Shan or Celestial Mountains in Western Mongolia. Small as it was, the collection was sufficient to show that *Melitæa* is a dominant element in the insect fauna of the locality. The large "Skipper," *Hesperia antonia* Spey, was also abundantly represented, and I was at once struck with the marked resemblance which its under surface would bear in the position of rest to that of the species of *Melitæa*. The striking feature of the latter genus is supplied by two black-bordered orange bands which cross the hind wings and stand out conspicuously against the cream ground-colour. These two bands, the outer with its festooned, the inner with its irregular borders, present a highly characteristic appearance. The small portion of the fore wing under surface exposed in the position of rest conforms, as is usual in butterflies, to the pattern of the hind and appears as a slight extension of its area. In spite of differences in detail, the two orange bands of the Hesperid closely resemble those of *Melitæa*, and in all essential respects the exposed under surface of the former reproduces that of the latter. In the Skipper the outer margin of the outer band is cut into internervular concavities, while the inner bulges into corresponding convexities: in the Nymphaline, concavities are seen along both borders. The orange of the bands and the tint of the ground-colour—white between the bands, greyish elsewhere—are also much paler in the Skipper, but the orange pigment is probably quite different from that of *Melitæa* and may rapidly fade. It is also interesting to note that the orange bands of the under surface are represented by black bands on the upper surface of the Skipper but by orange bands on that of the Nymphaline. The allied *Hesperia sida* Esp., with golden bands, is doubtless a co-mimic with *H. antonia*, while in a third closely related species, *H. carthami* Hübn., the dark bands have gained a bronzy greenish or yellowish tinge, probably indicating the kind of variation out of which the pattern of the two first-named species was produced by selection.

Probable evidence that *Melitæa* is a specially protected genus is supplied by the well-known habits of the three British species *aurivia* (= *artemis*) Rott., *cinxia* L., and *athalia* Rott. All are known to be gregarious in the larval state, and so abundant in confined localities that they may be described as gregarious in the perfect state also. All are slow-flying and conspicuous on the wing and at rest between the flights, while individuals have been observed to "sham death" when captured. Putting all the facts together, it appeared probable that we have an interesting addition to the list of mimics among the Palearctic butterflies, a list which is remarkably short in the western section of the Region. Mr. Pocock kindly consented to test the hypothesis that *Melitæa* possesses the distasteful qualities of a model for mimicry, and Commander J. J. Walker kindly helped to obtain material for

the experiments which are recorded on pp. 825-827. The results as a whole leave little doubt that *Melitæa* is distasteful to many birds, and that it does actually possess the qualities which would render it an advantageous model for the Hesperiidæ.

Pages 827-830.

The experiments on *Melanargia galathea* are of peculiar interest. The northern belt Satyrinæ of this genus, with their white ground-colour, stand out from the rest of their group. The under surfaces are conspicuous, the species slow-flying and so abundant locally that they may be called gregarious. The observations here recorded show that they are also distinguished by their greater distastefulness from other common northern Satyrines. The appearance of the species of *Melanargia*, especially on the wing, is markedly Pierine-like, and it is here also probable that a highly distasteful genus has mimicked an assemblage of species which, although generally less unpalatable, are excessively widespread and abundant in individuals (see also p. 865).

Pages 830-831.

The experiments upon Lycenidæ, Nemeobiinæ, and Hesperiidæ were not sufficiently numerous to form the foundation for safe conclusions.

Pages 831-855.

The remaining experiments, for the most part, afford valuable confirmation of previous work, but they also raise new questions of great interest. Confirmation is afforded by the evident unpalatability of *Zygæna*, *Euchelia*, and *Abraxas* among the moths, of the Saw-fly larvæ, of the Telephoridæ, Phytophaga, and Coccinellidæ among the beetles, and of the Hemiptera, as also by the special and peculiar defensive secretions of the Carabidæ and, in sharp contrast to all these observations, by the palatability of the procryptically coloured moths and larvæ.

Pages 847-848.

The apparent distastefulness of the humble-bee-like *Volucella bombylans* suggests conclusions of so much importance and interest that abundant confirmation is essential, and should be readily available with so common a species.

Pages 848-852.

Experimental evidence that the Aculeate Hymenoptera possess some special defence independently of the stings of the females is now obtained for the first time. It was suggested as probable by the present writer in 1904, as a result of the observation that the males of the bee *Sphecodes* emerge in immense numbers and form complex mimetic associations, before the appearance of the females, as also from the consideration that the Braconidæ are extensively mimicked*.

* Trans. Ent. Soc. Lond. 1904, pp. 645-6.

Page 849.

Although so many insectivorous animals in confinement disregarded the special defence of *Formica rufa*, there can be little doubt that such defence is very effective in the wild state. It is impossible on any other hypothesis to account for the conditions under which the species exists—swarming in vast numbers in restricted areas and an easy prey to any enemy that would dare to attack.

A very important conclusion is suggested by several of the experiments recorded in this memoir, namely, that the tastes of mammals and birds are widely different. The author points out that the defence of the ground-beetles appealed more strongly to the mammals than to the birds, but it was also apparent in many of the experiments that the unpalatability of conspicuous Lepidoptera was, conversely, far more obvious to the birds than to the mammals. In view of the part which birds are believed to play in the production of mimetic resemblance, it is obvious that this inference may be highly significant.

ADDENDUM.

DR. P. CHALMERS MITCHELL'S Memoir "On Longevity and Relative Viability in Mammals and Birds," P. Z. S. 1911, p. 425.

[The Rev. F. C. R. JOURDAIN has kindly called my attention to the fact that I have overlooked a valuable paper "On the Duration of Life of the Animals in the Zoological Garden at Frankfort-on-the-Main," by Director Dr. MAX SCHMIDT, P. Z. S. 1880, p. 299, and containing many valuable figures as to longevity].—*P. C. M.*, Aug. 2, 1911.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

June 13th, 1911.

EDWIN T. NEWTON, Esq., F.R.S., in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. H. G. PLIMMER, F.R.S., Pathologist to the Society, presented a Report on the Pathological Examination of Rats caught in the Regent's Park and in the Society's Gardens. 500 rats had been examined between the 1st of January and the 17th of May, 1911, all in a precisely similar manner. The spleen, lungs, glands, and blood were examined microscopically; and from any animal which looked in any way unhealthy cultures were made.

The results were summarized as follows:—5 rats were caught in the Park, and 495 in the Gardens: 283 of these were males and 217 females.

3 rats had tubercle, 10 had tapeworm cysts in the liver, 49 had *Trypanosoma lewisi* in their blood, 2 had empyema (not tubercular), 1 had a tumour of the lower jaw (the result of an old injury), and 1 had pleuritis and hydrothorax (not tubercular).

Bacteria were found in 71 rats: in 40 in the lungs, and in 31 in the spleen.

Saccharomycetes were found in the lungs of 16 rats.

Fleas were found on 4 rats, and lice on 3 rats.

The general condition of the rats was very good, and in none was anything at all suspicious found.

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Mr. R. I. Pocock, F.R.S., F.Z.S., the Society's Curator of Mammals, exhibited the skin and skull of a Crested Rat (*Lophiomys ibeanus*), sent from British East Africa by Mr. R. B. Woosnam, and after drawing attention to the characters of the skull in this genus, said that in his opinion the coloration was for the purpose of self-advertisement and rendered the animal conspicuous at night.

Dr. R. W. SHUFELDT, C.M.Z.S., sent for exhibition a photograph he had taken of a living specimen of a male albino Woodchuck, *Arctomys monax*, that had been sent to him from Virginia, U.S.A.

Mr. R. E. HOLDING exhibited and made remarks upon the Horns of a Highland Ram, a Fallow Deer, and a Roebuck, which were fused at the base, and also the skull of a coursing Greyhound with abnormal dentition.

Dr. R. E. DRAKE-BROCKMAN, F.Z.S., read a paper on Antelopes of the genera *Madoqua* and *Rhynchotragus* found in Somaliland, specimens of most of which were exhibited at the Meeting. He made general remarks on all the Dik-diks and gave a short account of the species and subspecies, including the description of a new form.

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A paper entitled "A Contribution to the Ornithology of Western Colombia," by Mr. C. E. HELLMAYR, was communicated by Dr. P. L. SCLATER, F.R.S. This memoir was based on a collection made by Mr. M. G. Palmer in 1908 and 1909, which, though numbering hardly 700 specimens, was of considerable interest and contained many rare species, and also furnished information of importance to students of zoogeographical problems.

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June 27th, 1911.

FREDERICK GILLETT, Esq., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions that had been made to the Society's Menagerie during the month of May 1911.

Dr. W. T. CALMAN, F.Z.S., exhibited a number of living specimens of the Brine Shrimp (*Artemia salina*) which had been bred from Tidman's Sea Salt. He remarked that this sea salt, as sold in the shops, was found frequently to contain living eggs of *Artemia* and that it was easy to obtain a supply of living specimens. An 8 per cent. solution, allowed to stand for a few days, produced a swarm of larvæ, and these could be fed on the strained juice of green leaves and raised to maturity.

Mr. J. LEWIS BONHOTE, M.A., F.Z.S., exhibited a pair of Egyptian Desert-Mice (*Meriones crassus*) which showed a darker and more rufous colour than normal examples. This coloration had been artificially produced by keeping the animals in a moist atmosphere at 80° Fahr. They were first exposed to these conditions on the 7th of April and a month later were conspicuously darker; after that the darkening process still continued, but more slowly, and they appeared for some time previous to being killed

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to have reached a limit to their darkening. During this same period, and owing to the fine weather, other examples had been in a temperature that rose during the day to 90°, falling at night to 60° or even lower. This had apparently produced no change in their coloration. The change in the examples exhibited was therefore due probably rather to the humidity than to the temperature. Mr. Bonhote was therefore inclined to think that the pale colour of desert animals was due to the extreme dryness of the atmosphere rather than to any special assimilation of their colour to the surroundings.

Mr. R. I. POCKOCK, F.R.S., F.Z.S., Superintendent of the Gardens, exhibited photographs of a hybrid between the Somaliland Wild Donkey (*Equus asinus somaliensis*) ♂ and the Mountain Zebra (*Equus zebra*) ♀, and remarked that although Mountain Zebras and domestic Asses had been previously crossed, no hybrid had hitherto been produced between this Zebra and the Somaliland race of *Equus asinus*. The period of gestation was twelve months and three weeks exactly. The foal showed much greater resemblance to *Equus asinus* than to *E. zebra*, the body being practically unbanded, except for the spinal and shoulder stripes. The stripes on the legs extended as high as the level of the belly and were broader and more numerous than in the sire and narrower and fewer than in the dam. In the presence of the shoulder stripe, the spinal stripe, and the stripe on the base of the ear, the foal resembled typical examples of *Equus asinus* and differed from its actual sire, which was without those marks.

Mr. D. SETH-SMITH, F.Z.S., the Society's Curator of Birds, exhibited two immature Black-backed Porphyrions (*Porphyrio melanonotus*) which had been bred in the Gardens, and remarked upon their possession of a well-developed claw on the pollex. Although these wing-claws were said to be functional only in the Hoatzin amongst living birds, the exhibitor believed that they were so also in the present species as also probably in the Common Moorhen, these birds using these appendages to assist them in climbing amongst reeds and other herbage.

The SECRETARY remarked that on a recent visit to the Ostrich Farm of Mr. Carl Hagenbeck at Stellingen, near Hamburg, he had seen in the incubator fertile eggs of *Struthio massaicus* from German East Africa, *S. australis* from South Africa, and *S. molybdophanes* from Somaliland, the eggs all having been laid at Stellingen. A. Reichenow ('Die Vögel Africas,' vol. i. p. 7) had already described and figured certain specific differences in the number and arrangement of the pits on the eggs of these species. He himself had been interested to notice that the eggs of the Masai Ostrich were much larger than those of the others, more spherical in shape, and very smooth and porcelaneous in texture. Those of the Cape Ostrich were somewhat similar in shape and

texture, but were much smaller; Mr. Hagenbeck had informed him that a pair of the Masai Ostrich bred by himself and sent out to the Cape were regarded by expert ostrich farmers there as unusually large birds. The eggs of the Somali Ostrich were larger than those of the Cape Ostrich, but smaller than those of the Masai species, and were markedly oval in shape with a rougher, less polished surface.

The SECRETARY remarked that on his recent visit to Mr. Hagenbeck's Zoological Park at Stellingen, near Hamburg, he had the pleasure of seeing a fine young pair of the common African Rhinoceros, obtained from British East Africa, the exact locality being unknown. The male closely resembled the ordinary figures and mounted examples of the species, in that the skin appeared to be smoothly stretched over the sides of the body, but the ears were fringed with long tufts of hair. The female, on the other hand, had no hair on the margin of the ears, and the general external appearance was very different. At first sight it seemed as if it were in very poor condition, the ribs standing out through the skin, but closer inspection showed that in reality the skin of the flanks was disposed in thick, permanent folds, arranged roughly like ribs. Thinking it possible that these differences might indicate the existence of distinct races of the Rhinoceros, on returning to London he had at once examined the Society's own pair of examples of this species, both of which had come from British East Africa, probably somewhere near Nairobi. The female, purchased in 1906, had the ears unfringed with hair, like those of Mr. Hagenbeck's female, but the rib-folds on the skin were no more than indicated, although there were very heavy permanent folds round the neck. In the male, obtained in the current year from Nairobi as part of the King's African Collection, the ears were fringed with hair as in Mr. Hagenbeck's male, whilst the rib-like folds on the skin were extremely strongly marked, as in the case of Mr. Hagenbeck's female. The presence or absence of the marginal fringe on the ears was therefore probably either an individually variable or a sexual character. In the absence of knowledge of the exact provenance of all the four examples, nothing could be said as to whether or no the presence of the rib-like permanent folds on the body were racial. Their existence, however, as well as the presence of the heavy fold round the neck, showed that it was not correct to distinguish the Asiatic Rhinoceroses from those of Africa by the presence in the former of permanent skin-folds. The neck-fold was almost identical in both, whilst, although they were differently arranged, deep body-folds occurred in both.

Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S., communicated a paper by Dr. R. BROOM, C.M.Z.S., entitled "On some new South African Permian Reptiles,"

Mr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper "On two new Genera of Cestodes from Mammals," based on specimens collected from animals in the Society's Gardens.

A paper was received from Miss RUTH HARRISON, entitled "Some Madreporaria from the Persian Gulf; with a Note on the Memoir and some Further Notes on *Pyrophyllia inflata* by SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., F.Z.S." This memoir dealt with a collection of corals made by Mr. F. W. Townsend, the most interesting species obtained being *P. inflata* and *Trematotrochus zelandiae*, the latter of which was identical with the specimens from Cook's Straits, New Zealand, described as *Conocyathus zelandiae* by Prof. Martin Duncan. A new species of *Heterocyathus* was described, and Professor Hickson appended a note on the affinities of *Pyrophyllia*.

Mr. C. L. BOULENGER, M.A., F.Z.S., contributed a paper "On Variation in the Medusa of *Mærisia lyonsi*," based on an examination of 400 specimens. Nearly 14 per cent. of these were found to be abnormal, and to fall naturally into two well-marked groups containing completely distinct phenomena. The author discussed these separately and in detail, and stated that he knew of no form in which such a variety of abnormalities occurred as in *Mærisia*.

Mr. CYRIL CROSSLAND, F.Z.S., presented two papers, entitled "The Marginal Processes of Lamellibranch Shells" and "Warning Coloration in a Nudibranch Mollusc and in a Chameleon." As a pendant to the second of these Sir CHARLES ELIOT, K.C.M.G., C.B., F.Z.S., contributed a paper on "Chromodorids from the Red Sea collected and figured by Mr. Crossland," containing an account of three species of *Chromodoris*, which were noteworthy as being varieties of known species or forms hitherto imperfectly described.

This Meeting closes the Session 1910-1911. The next Meeting of the Society for Scientific Business will be held on Tuesday, October 24th, 1911, at half-past Eight o'clock P.M.

The following Papers have been received :—

1. A. D. IMMS, D.Sc., B.A.

On some Collembola from India, Burma, and Ceylon, with a Catalogue of the Oriental Species of the Order.

2. Prof. P. P. SUSHKIN, C.M.Z.S.

Ontogenetical Transformations of the Bill in *Ardea cinerea*.

3. E. P. STEBBING, F.L.S., F.Z.S.

Game Sanctuaries and Game Protection in India.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

July 4th, 1911.

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The 'Proceedings' for the year are issued in *four* parts, *paged consecutively*, so that the complete reference is now P. Z. S. 1911, p. . . . The Distribution is as follows:—

Part	I.	issued in	March
"	II.	"	June.
"	III.	"	September.
"	IV.	"	December.

'Proceedings,' 1911, Part II. (pp. 181-555), were published on July 6th, 1911.

'The Abstracts of the Proceedings,' Nos. 98 and 99, are contained in this Part.

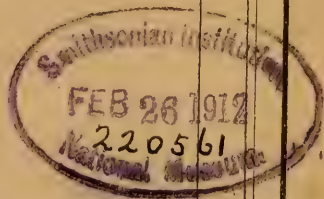
PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.
1911.

PART IV.
CONTAINING PAGES 869 TO 1213, WITH 22 PLATES
AND 64 TEXT-FIGURES.

DECEMBER 1911.

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THE ZOOLOGICAL SOCIETY OF LONDON.

THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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The Society consists of Fellows, and Honorary, Foreign, and Corresponding Members, elected according to the By-Laws. It carries out the objects of its foundation by means of the collection of living animals, by its Library, and by its Scientific Publications.

The Office of the Society, Regent's Park, N.W., where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at Two P.M.

The Library, under the superintendence of Mr. F. H. Waterhouse, is open daily at the above hours, except in September.

The Meetings of the Society for General Business are held in the Meeting Room at the Society's Office on the third Wednesday in every month of the year, except in September and October, at half-past Four o'clock P.M.

The Meetings for Scientific Business are held in the Meeting Room at the Society's Office fortnightly on Tuesdays, except in July, August, September, and December and January, at half-past Eight o'clock P.M.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four P.M.

The Society's Gardens are open daily from Nine o'clock until Sunset. Mr. R. I. Pocock, F.R.S., F.L.S., is the resident Superintendent and Curator of Mammals, Mr. D. Seth-Smith is Curator of Birds and Inspector of Works, and Mr. E. G. Boulenger is Curator of Reptiles. The Prosectorium for Anatomical and Pathological work is under the charge of Mr. Frank E. Beddard, M.A., F.R.S., Prosector, assisted by Mr. H. G. Plimmer, F.R.S., M.R.C.S., Pathologist to the Society.

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FELLOWS pay an Admission Fee of £5, and an Annual Contribution of £3, due on the 1st. of January, and payable in advance, or a Composition of £45 in lieu thereof; the whole payment, including the Admission Fee, being £50.

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Green and Buff Tickets may be used on any day and in any year, but in no case can two Children be admitted with one Adult's Ticket, or an Adult be admitted with two Children's Tickets.

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FELLOWS have the privilege of receiving the Society's ordinary Publications issued during the year upon payment of the additional Subscription of One Guinea. This Subscription is due upon the 1st. of January, and must be paid before the day of the Anniversary Meeting, after which the privilege lapses. FELLOWS are likewise entitled to purchase these Publications at 25 per cent. less than the price charged to the public. A further reduction of 25 per cent. is also made upon all purchases of Publications issued prior to 1881, if above the value of Five Pounds.

FELLOWS also have the privilege of subscribing to the Annual Volume of 'The Zoological Record,' which gives a list of the Works and Publications relating to Zoology in each year, for the sum of

* The Saturday Orders are not available if the Fellow introduces friends personally on that day.

One Pound Ten Shillings. Separate divisions of volumes 39 to 42 can also be supplied. Full particulars of these publications can be had on application to the Secretary.

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Any FELLOW, having paid all fees due to the Society, is at liberty to withdraw his or her name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with the undersigned.

P. CHALMERS MITCHELL,

Secretary.

Regent's Park, London, N.W.,
December, 1911.

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OF THE
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FOR
SCIENTIFIC BUSINESS.

1912.

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„ APRIL	2 & 23	„ NOVEMBER ..	12 & 26
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*The Chair will be taken at half-past Eight o'clock in the Evening
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ZOOLOGICAL SOCIETY OF LONDON.

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According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are issued in the volumes of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described therein. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, paged consecutively, in the months of March, June, September, and December. From January 1901 they have been issued as two half-yearly volumes, indexed separately.

An "Abstract of the Proceedings" is published by the Society on the Tuesday following the date of Meeting to which it refers. It is issued along with the "Proceedings," free of extra charge, to all Fellows who subscribe to the Publications, but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post free for the sum of Six Shillings per annum, payable in advance.

The "Transactions" contain such of the communications made to the scientific meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

Fellows and Corresponding Members, upon payment of a Subscription of One Guinea *before* the day of the Anniversary Meeting in each year, are entitled to receive the Society's Publications for the year. They are likewise entitled to purchase the Publications of the Society at 25 per cent. less than the price charged for them to the Public. A further reduction of 25 per cent. is made upon purchases of Publications issued prior to 1881, if they exceed the value of five pounds.

Fellows also have the privilege of subscribing to the Annual Volume of the Zoological Record for a sum of 30s. (which includes cost of delivery), payable on the 1st. of July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st. of December following.

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"	XVII., " 41 " .. (1903-1906) ..	5	18 6	7	18 0
"	XVIII., " 43 " .. (1907-1911) ..	4	1 0	5	8 0
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P. CHALMERS MITCHELL,

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REGENT'S PARK, LONDON, N.W.

December, 1911.

EXHIBITIONS AND NOTICES.

May 23, 1911.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

THE SECRETARY read the following report on the additions made to the Society's Menagerie during the month of April, 1911 :—

The number of registered additions to the Society's Menagerie during the month of April last was 274. Of these 75 were acquired by presentation, 147 by purchase, 34 were received on deposit, 5 in exchange, and 13 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 169.

Amongst the additions special attention may be directed to :—

1 Black Serval (*Felis serval*), from Nairobi, presented by the Marchioness of Donegal to H.M. THE KING's African Collection, on April 25th.

2 Bactrian Camels (*Camelus bactrianus*), from Central Asia, and 1 Yak (*Poëphagus grunniens*), from Tibet, presented on April 4th and 29th respectively, by H.G. The Duke of Bedford, K.G., President of the Society.

1 Klipspringer (*Oreotragus saltator*), from Somaliland, presented by R. E. Drake-Brockman, Esq., M.R.C.S., F.Z.S., to H.M. THE KING's African Collection, on April 28th.

1 Savannah Deer (*Dorcelaphus savannarum*), from Iquique, Chile, presented on April 24th by Miss Peggy Lomax.

1 Black-tailed Oribi (*Ourebia nigricaudata*), from the Ivory Coast, presented by F. W. F. Jackson, Esq., to H.M. THE KING's African Collection, on April 4th.

2 Australian Bee-eaters (*Merops ornatus*), from New South Wales, new to the Collection, purchased on April 30th.

2 Woodhouse's Jays (*Aphelocoma woodhousei*), from North America, and 3 Pigmy Ground-Doves (*Chamaepelia minuta*), from South America, new to the Collection, received in exchange on April 1st.

2 Sharpe's Wood-Owls (*Syrnium nuchale*), 1 Fraser's Eagle-Owl (*Bubo poënsis*), 1 Beautiful Wood-Hawk (*Dryotriorchis spectabilis*), and 1 One-streaked Hawk (*Melierax monogrammicus*), from Dunkwa, Gold Coast, presented by Dr. H. G. F. Spurrell to H.M. THE KING's African Collection, on April 2nd.

4 Gigantic Salamanders (*Megalobatrachus maximus*), from Japan, purchased on April 28th.

The Rev. A. MILES MOSS, M.A., F.Z.S., F.E.S., gave a short account of his memoir on the Sphingidæ of Peru, based on studies of Lepidoptera, with special reference to the larvæ, which he had made during a three years' residence at Lima.

This paper will be published in the 'Transactions' in due course.

PAPERS.

37. The Alcyonaria of the Cape of Good Hope and Natal.—
GORGONACEA. By J. STUART THOMSON, Ph.D., F.R.S.E.,
F.L.S., Lecturer and Senior Demonstrator in Zoology,
University of Manchester*.

[Received May 4, 1911: Read May 23, 1911.]

(Plates XLIII.–XLV.† and Text-figure 167.)

The Alcyonaria here reported on were collected during the years 1898 to 1907, off the coasts of Cape Colony and Natal. In a previous paper‡ I dealt with the Alcyonacea, and in the present report I confine myself to the Gorgonacea. This contribution is not, however, to be regarded as an exhaustive one, as, unfortunately, the specimens have come into my hands at different times. Professor Hickson has contributed two papers on South African Alcyonaria to the publication, 'Marine Investigations in South Africa,' and I have to thank him for allowing me to examine his type-specimens and microscopic slides of the spicules of various forms.

I have also to thank Professor J. D. F. Gilchrist, formerly Government Biologist at the Cape of Good Hope, who kindly entrusted these Alcyonarians to me for description.

In this paper, the following 19 species are described or recorded, of which 6 are new:—

Family BRIAREIDÆ.

Suberia capensis, sp. n., p. 871.

Spongioderma verrucosum Möbius, p. 874.

Family MELITODIDÆ.

Melitodes esperi W. & S., p. 874.

Melitodes nodosa W. & S., p. 876.

Melitodes dichotoma Pall., p. 877.

Family ISIDÆ.

Ceratoisis ramosa Hickson, p. 877.

Family MURICEIDÆ.

Muriceides fusca, sp. n., p. 878.

Acanthogorgia armata Verrill, p. 880.

* Communicated by Prof. ARTHUR DENDY, D.Sc., F.R.S., F.Z.S.

† For explanation of the Plates see pp. 892–893.

‡ "The Alcyonaria of the Cape of Good Hope and Natal.—Alcyonacea" (with our plates). Trans. Roy. Society Edinburgh, vol. xlvii. part iii. (No. 19), 1910.



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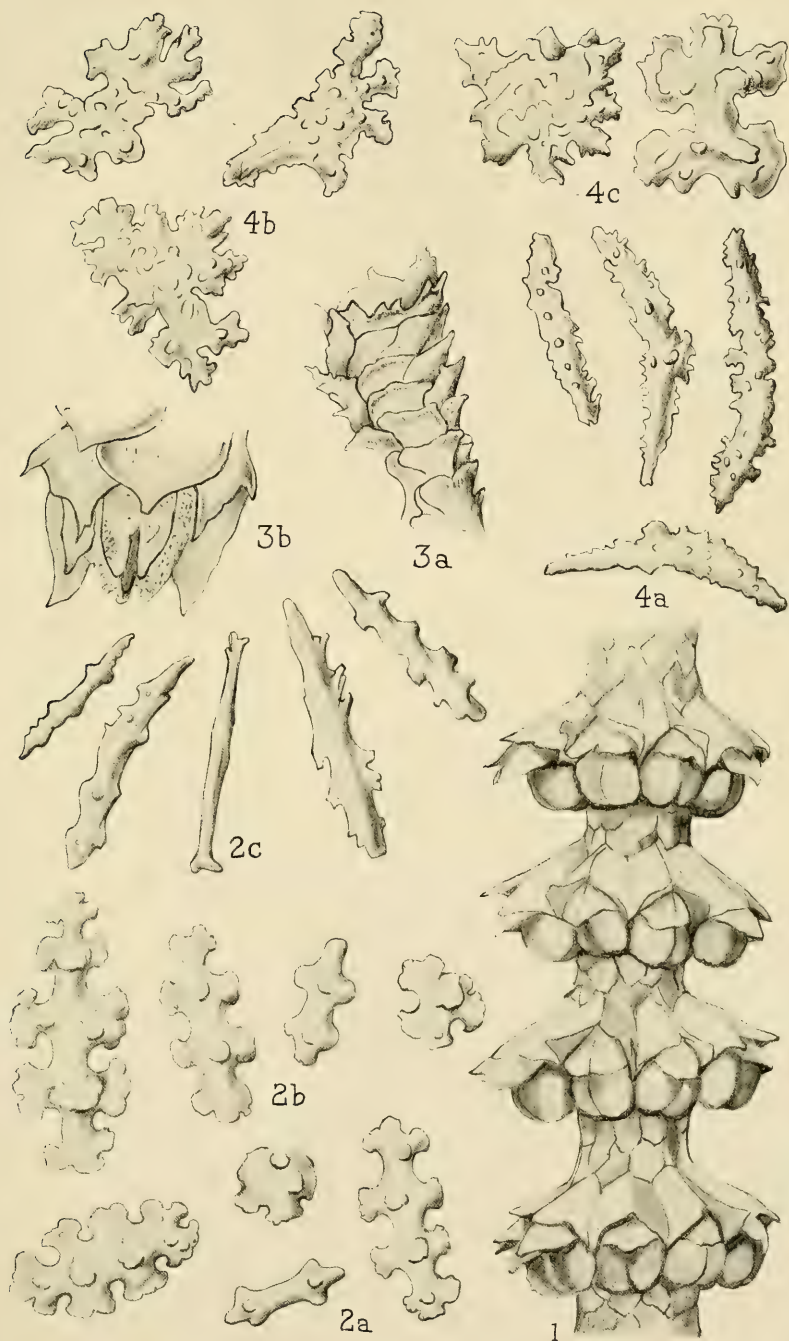
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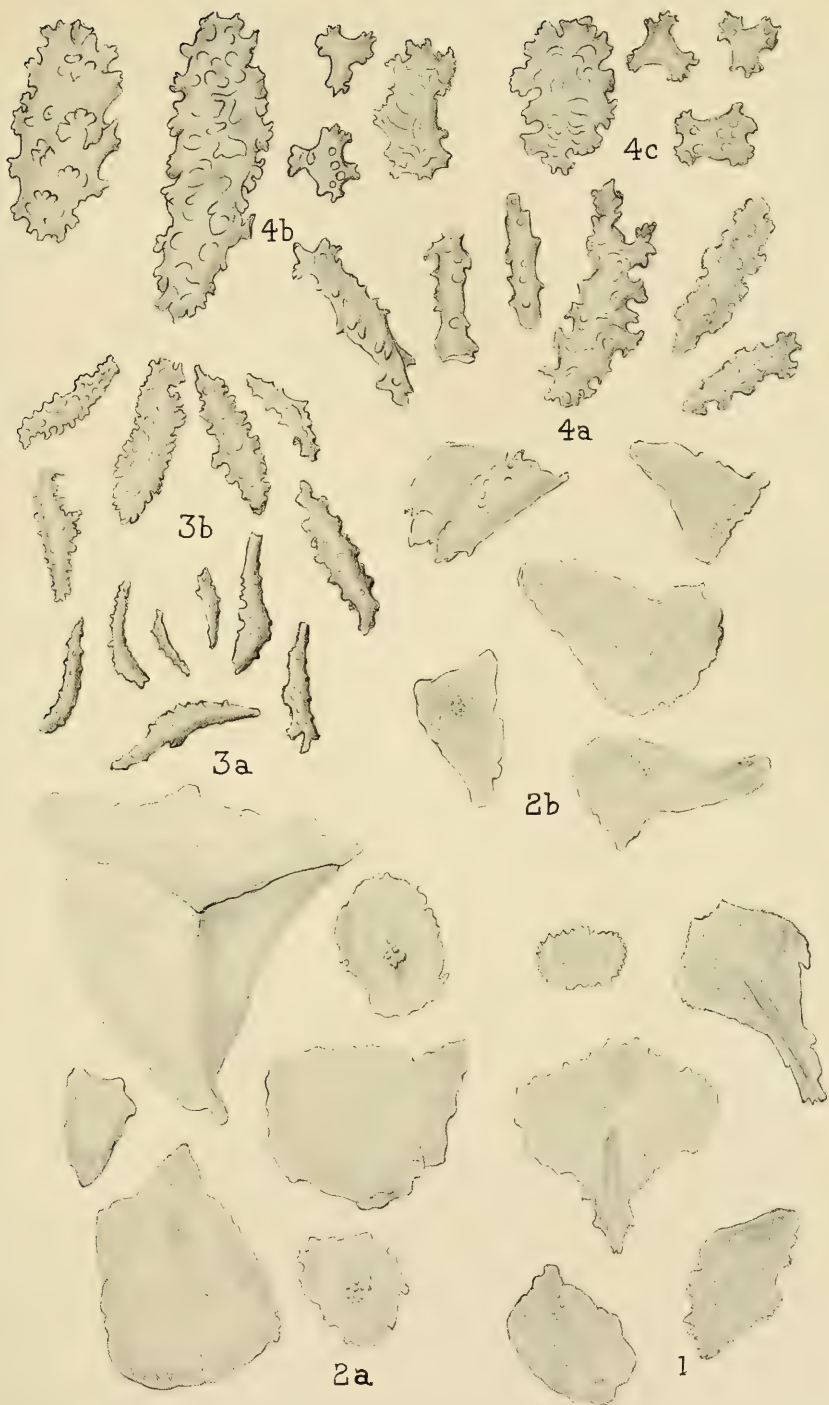


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5





ALCYONARIA OF THE CAPE OF GOOD HOPE.

Family PLEXAURIDÆ.

- Eunicella papillosa* Esper, p. 880.
Psammogorgia pulchra, sp. n., p. 881.
Euplexaura media, sp. n., p. 883.

Family MALACOGORGIIDÆ.

- Malacogorgia capensis* Hickson, p. 884.

Family PRIMNOIDÆ.

- Stachyodes gilchristi*, sp. n., p. 885.
Thouarella hicksoni, sp. n., p. 886.

Family GORGONIIDÆ.

- Gorgonia capensis* Hickson, p. 887.
Gorgonia flammea E. & S., p. 888.

Family GORGONELLIDÆ.

- Scirpearia furcata* emend. Simpson, p. 888.
Scirpearia flagellum emend. Simpson, p. 888.
Hicksonella spiralis Simpson = *Juncella spiralis*
 Hickson, p. 889.

Family BRIAREIDÆ.

SUBERIA CAPENSIS, sp. n. (Pl. XLIII. fig. 4; Pl. XLV. figs. 4a-c.)

The colony is of a dark red colour, resembling that of *Gorgonia flammea* E. & S., and consists of (1) an encrusting base, (2) a more or less cylindrical trunk, and (3) an expanded apical part. The basal part is 10 mm. long, 13 mm. broad, and 6 mm. high. The trunk is about 27 mm. in height, 6 mm. in diameter basally and medially, and about 7 mm. apically. The lowest polyp is situated on the trunk about 13 mm. from the base. About fourteen polyps are situated near the apex of the trunk, and these are almost entirely confined to three sides. The largest polyps of this part are 2 mm. in height and 3 mm. in diameter. The distance of the polyps from one another varies considerably, namely from about 1 to 3 mm. The apical part of the colony is about 14 mm. in height and 15-17 mm. in diameter (including the polyps). The polyps are in this part more prominent than in the trunk region. They vary from 2-3 mm. in height and breadth. The polyps are irregularly scattered over the surface of the apical part, and the interval between them varies from about 1 to 5 mm. There are thirty to forty polyps in the apical part.

The entire surface of the colony is rough to the touch and has a tough consistency. In the centre of the colony there is a horny and limy axis; in other words, the axis consists of horny tissue and in association with this a large number of spicules. The spicules of the axis usually differ in form from those of the cortex.

There is a ring of canals immediately surrounding the axis and another ring occurs in the cortex. The polyps are retractile within the verrucæ. In my specimen all the polyps are retracted. Spicules are present in the anthocodæ.

The spicules of the polyps are (1) small tri-radiate spicules with sharp spines on the blunt ends of the rays, this being the commonest type of spicules in the polyps; (2) rods with spines on the expanded ends, some of which approach a dumbbell shape; (3) approximately straight rods; and (4) spindles. The spicules are arranged in eight longitudinal bands on the anthocodæ and do not appear to be in any definite arrangement in relation to one another. They are all red in colour.

The spicules of the axial part of the trunk are (1) colourless rods with few spines, (2) spindles with blunt processes, the latter with spines or thorns, and (3) irregularly-shaped spicules.

The spicules of the cortex of the trunk are most frequently spindles (with a similar shape to those of the axial part), tri-radiate spicules, short rods, and small irregularly-shaped spicules. The spindles are more characteristic of the cortex, and the rods of the axial part. The wall of the stomodæum contains numerous small red spicules, mostly tri-radiate forms.

The dimensions of the spicules are as follows:—From the polyps: (1) large spindles, from 0.119×0.085 to 0.188×0.119 mm.; (2) tri-radiate forms, from 0.051×0.0357 to 0.068×0.068 mm.; (3) 4-rayed forms, from 0.051×0.0425 to 0.068×0.051 mm.; (4) small dumbbell-like forms, but with double ends, about 0.051×0.020 mm.

From the cortex of the trunk: (1) large spindles, from 0.0935×0.0595 to 0.221×0.119 mm.; (2) small tri-radiate forms, from 0.0357×0.051 to 0.0595×0.022 mm.; (3) dumbbell-like forms approximately the same size as those of the polyp.

From the axial part of the trunk: (1) large spindles (only a few occur), from 0.204×0.1105 to 0.289×0.0935 mm.; (2) rods, from 0.085×0.0255 to 0.272×0.0765 mm.; (3) irregularly-shaped spicules, from 0.238×0.119 to 0.340×0.119 mm.

Locality, etc.—"Pieter Faure," No. 13139. Cape Morgan, N.N.E. $9\frac{3}{4}$ miles. Depth, 47 fathoms. Procured by dredge. Nature of bottom, broken shells. Only one specimen of this species was collected.

Studer gives the following diagnosis of the genus *Suberia*:—

"Stamm einfach oder verzweigt, aufrecht, mit einer Achse, die aus unverschmolzenen, von Hornsubstanz umgebenen stabförmigen Spicula gebildet wird und der Ernährungscanäle entbehrt. Rinde dick, enthält spindelförmige stachelige Spicula. Die Polypenwarzen sind gross, senkrecht vom Stamme abstehend, die Öffnung an der Spitze der Warzen achtstrahlig. Die Polypen von der Basis bis in die Tentakel mit feinen spindelförmigen Spicula erfüllt. Um die Achse ein Kranz von Längscanälen."

Studer adds that the genus *Suberia* stands near *Spongioderma*, but differs from it in the form of the calyx and spicules.

Three species of the genus *Suberia* have been described, and the following table shows the differences between them so far as these can at present be stated.

<i>Suberia capensis</i> , sp. n.	<i>Suberia genthi</i> Str.	<i>Suberia koellikeri</i> Str.	<i>Suberia clavaria</i> Str.
Colour, dark red.		Rose-red, disappearing in alcohol.	Flesh-coloured during life, disappearing in alcohol.
Simple, unbranched.	Branched.	Branched.	Simple, unbranched.
Height 53 mm.	80 mm.	About 110 mm.	160 mm.
Trunk cylindrical, expanded at the apex.	Cylindrical.	Cylindrical, branches expanded at the apices.	Cylindrical, expanded at the apex.
Polyps at the apex but not terminal, 2-3 mm. in height.	Polyps not terminal.	1-1.5 mm. in height.	Polyps thickly crowded together at the apex, 1-2 mm. in height.
The rind is firm and rough.		The rind is thin and rough.	The rind is soft and smooth.
The spicules are:— (1) rods, (2) spindles, (3) tri-radiate forms, (4) 4-rayed forms, (5) irregular spicules.	(1) straight warty spindles, (2) curved warty spindles, (3) 4-rayed forms, (4) double crosses, (5) irregularly branched spicules.	(1) rod-like spicules, (2) cross-shaped or triplets.	(1) slightly spined spindle-shaped rods, (2) crosses, (3) spinous spindles.
No canals in axis.	Canals in the axis.	Axis surrounded by a wreath of canals.	Axis as in the last species "well separated" and consists of long, slightly spined, spindle-shaped rods; crosses also occur.
Canals immediately outside the axis.	Canals in the circumference.		
Axis of horny tissue with numerous associated spicules.		Axis consists of smooth rod-like spicules (with few spines) lying close to one another.	
Dimensions of Spicules:— Large spindles, from 0.0935 × 0.0595 to 0.0289 × 0.0935 mm.; tri-radiate forms, from 0.0357 × 0.051 to 0.068 × 0.068 mm. rods, from 0.085 × 0.0255 to 0.272 × 0.0765 mm.; irregularly-shaped spicules from 0.238 × 0.119 to 0.340 × 0.119 mm. dumbbell-shaped forms about 0.051 × 0.020 mm.	Straight, warty spicules, from 0.09 × 0.08 to 0.34 × 0.10 mm. curved, warty spindles from 0.24 × 0.12 to 0.30 × 0.10 mm.; long, spiny, curved spindles, from 0.4 × 0.04 to 0.24 × 0.4 mm.; irregularly branched spicules, from 0.24 to 0.06 mm. in widest diameter; 4-rayed forms, 0.32 to 0.06 and 0.20 to 0.12 mm.; double crosses, from 0.1 to 0.025 and 0.08 to 0.01 mm.	Warty, thorny spicules, 0.24 and 0.021 mm. in length; rods ("Drillings") from axis, 0.35 mm.	Spinous spindles from the rind, 0.1 to 0.18 mm. in length; long, slightly spined, spindle-shaped rods, 0.237 and 0.265 mm. in length.
Habitat:—South Africa, Cape Morgan, N.N.E., 9½ miles. Depth, 47 fms. By dredge. Bottom, broken shells.	Shallow water, off Port Jackson (Australia).	North of New Zealand.	Atlantic, off Monte Video

SPONGIODERMA VERRUCOSUM Möbius.

This species has already been described from South African waters by Hickson in his paper on the Alecyonaria and Hydrocorallinæ of the Cape of Good Hope, Part I.

Localities, etc.—Apparently a shallow-water form.

"Pieter Faure," 12310. Port Shepstone, north, 8 miles. By dredge. Depth, 36 fathoms. Nature of bottom, broken shells and stones. Date, October 30, 1902.

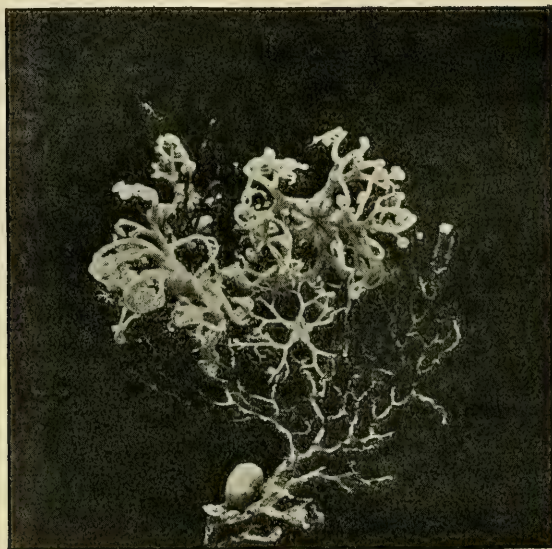
"Pieter Faure," 11127. Umkomass River mouth, N.W. by W. $\frac{1}{2}$ W. $5\frac{1}{2}$ miles. By large dredge. Depth, 40 fathoms. Nature of bottom, broken shells and stones. Date, December 30, 1900.

Family MELITODIDÆ.

MELITODES ESPERI W. & S. (Text-fig. 167.)

The specimen is about 104 mm. in length and 117 mm. in breadth, but these dimensions are only approximate as several of the terminal branches were broken away. The colony had three beautiful young specimens of *Gorgonocephalus* intertwined among its branches.

Text-fig. 167.



Melitodes esperi and *Gorgonocephalus*.

The colony is red in colour, and is attached to the substratum by a broad, trunk-like base. The branches are mostly in one plane, although a few are slightly turned inwards in a direction

vertical to the main axis. There is a slight anastomosis of the branches; the meshes thus produced are very irregular in shape. Sometimes branches, which may be slightly divided, are seen growing into the meshes; these offshoots may arise from the internodes, but this is rare.

The nodes and internodes are very distinctly marked, the former being dark red and the latter light red in colour. The internodes vary in length from 2 mm. near the base to 9 mm. towards the apex of the colony. The nodes are more or less ring-shaped, but they have a slight projection in front. The nodes are smaller towards the apices of the branches than near the bases and are not so easily distinguished from the internodes. Near the base the nodes may be 4 mm. in length and 3 mm. in diameter; towards the apex they are about 1 mm. in length and diameter.

The axis consists of long needle-like spicules densely compressed together. The lower part of the axis is not perforated by canals. On a branch of average size, the diameter of the axis is about 1 mm. The internodes of the axis are pale pink, the nodes darker in colour.

The base of the colony is a thick trunk about 5 mm. in diameter, but it soon divides and gives rise to the branches. The branches are disposed in a more or less fan-shaped manner. Various organisms, such as Polyzoa, Brachiopods, and Hydroids, are thickly grouped at the base of the colony.

The *cœnenchyma* covering the axis is about $\frac{1}{6}$ of a millimetre in thickness: its surface is densely covered by an extremely large number of spicules of varied size and shape. A rough surface is produced by the slightly protruding spicules.

The contracted polyps appear as yellow papillæ on the surface of the *cœnenchyma*, and are about .6 mm. in height and 1 mm. in breadth. On the large, basal branches of the colony, the polyps are only distributed on three sides, but on the apical branches they occur on all sides. Polyps are situated on the nodes, and not simply confined to the internodes. The spicules of the polyps are yellow, and are arranged in eight areas.

The spicules of the *cœnenchyma* are of the following forms:—

Clubs, with broad leaf-like processes; curved spindles with narrow processes, some of these spicules are so much curved as almost to form a semicircle; straight spindles of two forms: (a) those with small processes, and (b) those with broad, expanded processes; other spicules are irregular in shape, owing to the presence of broad processes, which produce a more or less branched appearance; one of these spicules has, for example, three apical prongs or processes.

The spicules of the *cœnenchyma* are all red in colour.

The spicules of the polyps are as follows:—

Straight spindles fairly similar in form to those of the *cœnenchyma*; curved spindles, also fairly similar in shape to those of the *cœnenchyma*, some of these spindles are bifurcated at the end

in a similar manner to that shown by Wright and Studer for this species; straight rod-like spicules with rounded processes; clubs and spicules of an irregular shape.

The spicules of the polyps are yellow in colour.

The spicules of the cœnenchyma have the following dimensions:—(a) Clubs, from 0.102×0.054 to 0.187×0.076 mm.; (b) curved spindles, from 0.085×0.0204 to 0.238×0.047 mm.; (c) straight spindles, from 0.0765×0.0204 to 0.272×0.0646 mm.; (d) irregularly-shaped spicules, from 0.085×0.068 to 0.119×0.068 mm.

The dimensions of the polyp spicules are as follows:—(a) straight spindles, from 0.081×0.037 to 0.153×0.025 mm.; (b) curved spindles, from 0.122×0.034 to 0.187×0.034 mm.; (c) clubs, from 0.085×0.034 to 0.136×0.051 mm.; (d) irregular spicules, from 0.076×0.110 to 0.170×0.034 mm.

Locality, etc.—P.F. 852. About 25 miles east of East London. Lat. $32^{\circ} 48' 30''$ S.; Long. $28^{\circ} 11' 15''$ E. By shrimp trawl. Depth, 22 fathoms. Nature of bottom, mud. Date, January 11, 1899.

MELITODES NODOSA W. & S.

The specimen was not complete, the base being absent and many of the terminal branches had become broken away. The entire colony probably measured 230 mm. in length and 120 mm. in breadth. The branches all arise in one plane. The nodes are very prominent, measuring as much as 6 mm. in diameter and 5 mm. in height near the base of the colony, and 2 mm. in diameter and 1.5 mm. in height on the small apical branches. The internodes vary considerably in length, namely, from 2 mm. near the base of the colony to 12–13 mm. on the terminal branches. The internodes are more or less cylindrical, and their diameter varies from about 3 mm. near the base to 1 mm. at the apex. Several of the branches originate from the internodes, as in the specimens of this species collected by the 'Challenger.' There is a slight anastomosis near the base of the colony, produced by branches springing from the nodes.

On the upper branches the polyps are distributed on all sides; on the lower part, however, they are mostly confined to three sides. The polyps are retractile within well-defined verrucæ, which measure about 1 mm. in diameter and 0.75 mm. in height.

The ground colour of the colony is yellow, the nodes are brown, the verrucæ yellow. The axis, when deprived of the overlying cœnenchyma, is brown at the nodes and white at the internodes.

The cœnenchyma is rough owing to the presence of numerous spicules and has a thickness of 1–2 mm. The surface of the cœnenchyma has longitudinal grooves. The spicules of the cœnenchyma are (1) irregularly-curved spindles, (2) irregularly-branched spicules, (3) curved, spinous spindles, (4) 4-rayed forms. Their dimensions are as follows:—Irregularly-curved spindles, from 0.204×0.059 to 0.238×0.051 mm.; irregularly-branched spicules, from 0.0765×0.068 to 0.136×0.085 mm.; curved,

spinous spindles, from 0.153×0.025 to 0.170×0.025 mm.; 4-rayed forms, 0.051×0.051 mm.

The spicules of the polyps are (1) curved spindles, (2) straight spindles, and (3) irregular spicules. The dimensions of these spicules are as follows:—Curved spindles, from 0.136×0.017 to 0.250×0.034 mm.; straight spindles, from 0.023×0.051 to 0.255×0.056 mm.; irregular spicules, from 0.068×0.051 to 0.170×0.085 mm. The spicules of the polyps may be contrasted with those of the cœnenchyma by the predominance of straight and curved spindles.

The 'Challenger' specimens were collected (1) off the New Hebrides at a depth of 60–120 fathoms, (2) on *Hyalonema*-ground, off Japan, at a depth of 345 fathoms. These specimens differ from mine in the colour of the cœnenchyma and axis; the cœnenchyma being reddish brown and the axis yellowish red. In both, the polyps were yellow and the nodes darker than the internodes. The shape of the spicules of my specimen rather differs from that of the 'Challenger' forms, but, on the other hand, the spicules seem to vary so much within this species that I do not feel inclined to lay great stress on this point.

Locality, etc.—P.F. 18381. Off Flesh Point, N. 6 miles to Flesh Point, N. $\frac{3}{4}$ W. $6\frac{1}{2}$ miles. By large trawl. Date, January 15, 1904.

MELITODES DICHOTOMA Pall.

Fragments of a red variety of this species. This species has already been recorded from the Cape. It is interesting to note its occurrence in such shallow water, namely from 6–14 fathoms. At Gordon's Bay, in all probability it may be thrown up on the shore during storms, as is so much the case with *Gorgonia flammæa* E. & S.

Locality, etc.—P.F. 15725. Off Gordon's Bay. By dredge. Depth, 6–14 fathoms. Nature of bottom, rock. Date, October 20, 1902.

Family ISIDÆ.

CERATOISIS RAMOSA Hickson. (Plate XLIII. fig. 1.)

This beautiful form has already been described by Hickson from South African waters. The species is very fragile, and the delicate terminal branchlets are very liable to become broken away. In Hickson's specimen the base was wanting, but my specimens are more complete in this respect. The calcareous base measures about 8 mm. in length, 4 mm. in breadth, and 2 mm. in height.

The height of the complete specimen would be about 100 mm. The first part of the main stem immediately above the base is brown or bronze in colour.

My specimens agree with Hickson's description of forms collected off Vasco da Gama Peak at a depth of 230 fathoms.

The distribution of colour on the colony appears to vary. The

ivory-white internodes, as described by Hickson, appear to become reddish in the upper part of the colony, but this is apparently not always the case.

Locality, etc.—P.F. 13197. Cove Rock, N.W. $\frac{3}{4}$ W. $13\frac{1}{2}$ miles. By dredge. Depth, 80–130 fathoms. Nature of bottom, coral and rocks. Date, July 30, 1901.

Family MURICEIDÆ.

MURICEIDES FUSCA, sp. n. (Plate XLIV. figs. 4 a-c.)

The colonies are about 102 mm. in height and 95 mm. in breadth. The branches are all in one plane. The main trunk has a strong horny axis and an expanded base measuring 14 mm. in length and 12 mm. in breadth. The main trunk has a diameter of 5 mm. and gives off its first branch 13 mm. from the base. The branches of the first order are given off irregularly from the trunk, and these, in their turn, give off branches of the second order, which may also bear small terminal branches. The branches of any order do not, as a rule, originate opposite one another. The axis of all parts is thick, the cœnenchyma thin. The axis is brown near the base, and light yellow at the apices.

The main trunk is fairly cylindrical, but the branches are slightly flattened. This flattening of the branches appears to be due to the manner in which the cœnenchyma grows over the axis, as the latter is fairly cylindrical in shape. The upper branches are thin and flexible, but their apices are expanded. The polyps are mainly confined to three sides of the axis. The general surface of the cœnenchyma is covered by small, protruding spicules. These spicules do not overlap, but there are only minute spaces between them.

The polyps are also well protected by spicules. There is a crown of spindles, in which the spicules are disposed *en chevron*, in eight triangular areas which are very pointed towards the apices. In each of these triangular areas there appear to be about 8–12 spindles, which are placed more or less vertically to the surface. At the base of those areas the spindles are arranged in a continuous ring surrounding the polyp. The spindles forming the ring also overlap one another, but not to such an extent as those in the triangular areas. There appear to be about ten spicules at any one place in this ring, enumerating in a proximo-distal direction. Distally to this ring, spicules of another form are situated on the polyp wall. These are very protuberant, and stand more or less in a vertical direction. These spicules are "*Blattkeulen*" and pass over basally into small spicules of the same general form as those of the general surface of the cœnenchyma, namely "*Kalkkörper*." The entire polyp is thus well protected by spicules.

The polyps are capable of being withdrawn within the verrucæ, but the latter are small and do not rise any distance beyond the surface of the cœnenchyma. The polyps vary considerably as to

the degree of extension, but the apices of the tentacles are never seen to any extent.

In all the better expanded polyps, the crown of spindles is very apparent. This crown has frequently a reddish or brownish coloration. The general surface of the colony has a greyish colour, which is produced by the spicules.

Owing to the varying degree of extension, the polyps naturally vary considerably in size.

The verrucæ have minute lobes, measuring as much as 2 mm. in height and 1.6 mm. in diameter.

The cœnenchyma is thin at all parts and sometimes is 1 mm. in thickness.

The axis of the secondary branches varies in diameter, from about 1.3 mm. in the lower branches to 1 mm. in the apical branches.

The interval between the polyps varies from about .1 mm. to 1.9 mm. There is a terminal polyp at the apices of the branches.

The spicules of the crown of the polyp are straight or curved spindles, armed with blunt tubercles. The majority of the spindles are very much curved, but a few are straight. The tubercles have a tendency to great irregularity of shape, and vary very considerably. The spicules from this part also vary notably in shape, some being rod-like, others club-like, but there are all transitions between the different forms. The number of tubercles or spines also varies considerably, in some spicules there are scarcely any, in others they are numerous. In some of the more curved spindles there is a secondary offshoot from the main axis about the middle of its length.

The spicules of the lower part of the polyp differ, as a rule, in shape from those of the upper crown. Many of the spicules from this part are "*Blattkeulen*," others are more of the form termed by Kölliker "*Kalkkörper*." There is much variety in the shape of those spicules, probably every stage grading the one into the other. There are also a few spicules similar to those occurring in the crown of the polyp, namely curved spindles. There are other spicules which may be more appropriately termed spinous clubs.

The superficial spicules of the cœnenchyma are much smaller than those of the polyp. They are mostly small "*Kalkkörper*" with irregular blunt processes coming off in all directions, less frequently there are short spindles with broad processes.

The dimensions of the spicules are as follows:—Spindles of the polyp crown, from 0.102×0.017 to 0.340×0.085 mm.; "*Blattkeulen*" of the lower polyp, from 0.17×0.119 to 0.289×0.085 mm.; "*Kalkkörper*" of the lower polyp, from 0.153×0.119 to 0.204×0.153 mm.; "*Kalkkörper*" of the cœnenchyma, from 0.047×0.030 to 0.105×0.076 mm.; spindles of the cœnenchyma, from 0.030×0.023 to 0.088×0.061 mm.

There was unfortunately no label attached to this specimen, and thus the exact locality cannot be stated.

Nutting has given the following diagnosis of the genus *Muriceides* :—

“*MURICEIDES* W. & S. (emended).

Muriceides Studer + *Clematissa* Studer, Archiv f. Naturgesch., Jahrg. liii. Bd. i. pp. 54, 55.

Muriceides Wright & Studer + *Clematissa* Wright & Studer, ‘Challenger’ Reports, the Alcyonaria, 1889, pp. lii, liii, 105, 106.

“Calyces cylindrical, or in the form of truncated cones, their walls filled with vertically-placed spindles, often modified into clubs, discs, or triradiate forms vertically placed, but not ‘en chevron,’ and not forming a true crown of points around the margin. The opercular spindles are placed ‘en chevron’ on the tentacle bases. The cœnenchyma contains spicules of various forms, and the branches may, or may not, end in calyces.”

ACANTHOGORGIA ARMATA Verrill.

The colony is irregularly branched. The cœnenchyma is thin, and filled with conspicuous, white spicules. The verrucæ are elongate, often curved, capitate or clavate, surmounted by eight groups of long, divergent, sharp spicules, with an irregular “chevroned” arrangement.

The axis has a yellowish-brown colour. The spicules are white, rough, curved, and fusiform. The colour of the colony is ash-grey.

This species has been previously recorded by Hickson from off Vasco da Gama Peak, 230 fathoms. There are three good examples in the present collection.

Locality, etc.—P.F. 18857. Cape Morgan, N. $\frac{3}{4}$ W. 13 miles. Depth, 250–320 fathoms. By shrimp trawl. Nature of bottom, broken shells. Date, July 8, 1906.

Family PLEXAURIDÆ.

EUNICELLA PAPILLOSA Esper. (Plate XLIII. figs. 2 & 3.)

The colony measures 162 mm. in length and 112 mm. in breadth. It has a basal encrusting part measuring 11 mm. in length and 15 mm. in breadth. The branches are all disposed in one plane. The verrucæ occur over the entire surface of the colony, even on the flat encrusting base. The main axis and most of the branches are cylindrical, but occasionally some of the upper branches are slightly flattened. Proceeding from the main stem, the branches gradually decrease in diameter but expand again near the apices. Some of the branches have a few local enlargements, but these are probably not of specific importance. The verrucæ give to the colony its papillated appearance; the largest are about 2 mm. in height and 1·2 mm. in diameter, the smallest are only fractions of a millimetre. The surfaces of the verrucæ are covered by a mass of spicules. A rough transverse

section through a branch shows (1) the horny brown axis in the centre, (2) a ring of canals grouped round the axis, and (3) externally, the cavities of the polyps arranged in a circumferential series.

The spicules are situated on the verrucæ, on the septa between the polyp cavities and surrounding the horny axis. These spicules are very abundant and are as a rule placed in a radial direction; they are of two kinds, viz. (1) the characteristic torch-like spicules and (2) spindles. The torch-like spicules measure about 0.068×0.025 and the spindles from 0.0935×0.034 to 0.136×0.0374 mm.

A portion of a colony of *Eunicella papillosa* was dredged in Simon's Bay during the voyage of the 'Challenger,' and Hickson has also recorded it from Rij Bank (Algoa Bay) at a depth of 25 fathoms. Hickson also draws attention to the remarkable resemblance between the spicules of *Gorgonia albicans* and those of *Eunicella papillosa*, more especially in regard to the torch-like spicules.

He says, "The examination of my preparations of spicules alone would lead any one to the conclusion that they were taken from the same species. Yet the specimen of *Eunicella papillosa* obtained on Rij Bank, 25 fathoms, has a cylindrical axis and prominent verrucæ, whilst the specimen of *Gorgonia albicans* picked up on the beach at Port Alfred has a very much flattened axis, thin ctenenchyma, and inconspicuous verrucæ."

Hickson thinks that there is justification in transferring *Eunicella papillosa* to the family Gorgoniidæ, and that *Eunicella papillosa* and *Gorgonia albicans* should probably be included in the same genus.

Locality, etc.—P.F. 15801. Off Seal Island, S.S.E. $2\frac{1}{2}$ miles, and Seal Island, S. by E. $2\frac{1}{2}$ miles. Procured by dredge. Depth, 9–10 fathoms. Nature of bottom, broken shells. Date, October 30, 1902.

PSAMMOGORGIA PULCHRA, sp. n. (Pl. XLIII. fig. 5; Pl. XLV. figs. 3 a & b.)

This very beautiful form has an orange ground-colour, with the red tips of the tentacles projecting. The colonies are not all complete. A small colony (P.F. 858) consists of a fairly flat, expanded, basal part which gives rise to two upright shoots, one of which branches into two, the other being simple. The basal part of the colony is 11 mm. in length, 6 mm. in breadth, and 3 mm. in height. The simple, upright shoot is 9 mm. in height, 2 mm. basally and 4 mm. apically in diameter. The other (divided) shoot is 28 mm. in height, 3 mm. in diameter at the base and 5 mm. at the apex. The branches are thus expanded at the apex. Another specimen (13345), which is probably not quite complete, has a very small basal part. The base gives rise to a main shoot (2 mm. in diameter), which at a distance of 9 mm. from its origin sends off a lateral branch about 12 mm. in height; a second small branch is given off from the main shoot after an

interval of 12 mm. This second branch measures 11 mm. in length and 3 mm. in diameter.

The main shoot is 21 mm. in height and has a diameter of 5–6 mm. at the apex.

The surface of the cœnenchyma is covered with large, yellow spicules, which are easily seen with the naked eye. They lie adjacent to one another but do not overlap, the boundaries of each being clearly defined. These superficial spicules of the cœnenchyma do not appear to be arranged in any very definite manner in relation to one another; they are of such varied sizes that any great regularity is prevented. It may, however, be observed that all the superficial spicules of the cœnenchyma have their long axes in the direction of the longitudinal axis of the colony; in the verrucæ, the spicules have a corresponding position in relation to the polyps.

The spicules of the cortex are (1) broad spindles, yellow in colour, (2) long narrow spindles, of a pale colour. The spicules project very much on the surface at all parts. The spicules of the anthocodiæ are red and are long spindles arranged 'en chevron' in eight longitudinal, triangular areas. At the base of these strips, a layer of spicules forms a ring round the polyp. This ring is composed of two or three spicules lying one behind the other in a proximo-distal direction.

The verrucæ have a circle of projecting spicules, only one layer deep. This circle consists of 14–16 yellow spicules which lie with their long axes parallel to the length of the polyps. These projecting spicules appear to be more prominent towards the apex of the colony. The general appearance of the polyp spicules reminds one, at first sight, of the setting of a stone in a finger-ring; the anthocodia with its red spicules resembling a jewel which is surrounded by little rivets, namely, the large, yellow spicules of the verrucæ. The degree to which the anthocodiæ are exposed beyond the verrucæ varies to some extent; as a rule, eight triangular areas are easily seen, in other cases there is only a minute area with spicules or only an opening at the apex of the verrucæ. The axis is horny in the centre, but with long narrow needles or spindles on its surface. These axial spicules are about 0.340 mm. in length and 0.051 in breadth; their margins are almost smooth. In a rough transverse section, the axis is seen to be composed of a large central grey area surrounded by a brown ring. The axis is not penetrated by canals.

The polyps occur on all parts of the colony including the basal encrusting part; they are arranged in a spiral manner on the branches. The polyps are about 1.5 mm. in height and 2 mm. in diameter.

The dimensions of the spicules are:—(1) large, yellow spindles, from 0.081×0.039 to 0.123×0.021 mm.; (2) small, yellow spindles, from 0.042×0.024 to 0.093×0.033 mm.; (3) red spindles, from 0.021×0.0015 to 0.114×0.0135 mm.; (4) long needle-like spicules of the axis, 0.340 mm. in length by 0.051 mm. in breadth.

Localities, etc.—P.F. 13345. Off Cape Morgan, N.N.W. 7 miles. Depth, 52 fathoms. By dredge. Nature of bottom, rocks, sand, and shells. Date, August 12, 1901.

P.F. 858. Off and east of Cape Morgan. Depth, 36 fathoms. By dredge. Nature of bottom, stones. Date, January 12, 1899.

Verrill's diagnosis of the genus *Psammogorgia* is as follows:—"Corallum dichotomous or subpinnate, with round branches. Axis horn-like. Cœnenchyma moderately thick, the surface finely granulated with small rough spicula. Cells scattered, sometimes flat, more frequently raised in the form of rounded verrucæ. Polyps with rather large, elongated, slender warty spindles at the bases of the tentacles. Spicula of the cœnenchyma mostly short, thick, and very rough, warty spindles and rough, warty clubs of moderate size."

Eleven other species of *Psammogorgia* have been described.

EUPLEXAURA MEDIA, sp. n. (Plate XLIV. figs. 2 a-c.)

The colour of the colony is bright red, with white polyps. A large part of the colony is concealed beneath a thick growth of Hydroids, and thus the exact dimensions of the specimen are rather uncertain. It was probably about 25 cm. in length.

In the lower part of the colony the axis is much flattened, but towards the apex it becomes rounded. The large axis near the base of the colony is 3·5 mm. in one diameter and 1·6 mm. in the narrow diameter. The axis is very small towards the apex of the colony, and is surrounded by the canals in a circular manner. The axis is hollow, and has the structure described by Wright and Studer for the genus *Euplexaura*.

The base of the colony is missing. The branches are all in one plane and vary in diameter at different parts of their length. They are thick near the base, narrower medianly, and expand again near the apex.

The polyps are arranged in an irregular spiral round the branches. The polyps are in many cases fairly well extended, but others are retracted and appear only as minute pores on the surface of the cœnenchyma. These pores vary in shape, some are circular or oval, others are slit-like and elongated in the direction of the long axis of the branch. The pores are from ·3 to ·5 mm. in diameter. A well-expanded polyp is about 1·2 mm. in length and ·5 mm. in diameter.

Each tentacle has about ten pairs of pinnules. The spicules are situated at the bases of the tentacles and extend in a distal direction. There is, firstly, a series of spicules on the polyp surface in a line with the tentacles, and, secondly, another series placed intermediate to the first. The second series has not so many spicules as the first. The spicules in each of these series are not arranged in a very regular manner.

The cœnenchyma is dense and granular. The spicules are arranged in a very dense layer in the cortex, but there are fewer towards the axis.

The spicules of the cortex are mostly spindles with irregular, blunt processes. Some have a simpler form than others. The spicules of the centre resemble those of the cortex, but simpler forms occur such as rods (with small processes) and crosses. The spicules of the polyps are very minute, needle-like or rod-like spicules, with blunt processes.

The dimensions of the spicules are as follows:—Spindles of the cortex, from 0.059×0.034 to 0.085×0.034 mm.; spindles of the centre, from 0.051×0.034 to 0.085×0.051 mm.; rod-like spicules of the polyps, from 0.064×0.008 to 0.112×0.034 mm.

This species resembles *Euplexaura braueri* Kükenthal, *E. albida* Kükenthal, and *E. parviclados* Wright & Studer. It has the closest resemblance to *Euplexaura braueri* Kükenthal, the spicules of which are almost identical with it except in size. My specimen differs, however, from *Euplexaura braueri* in the arrangement of the polyp spicules and in other points. From the shape of the spicules alone, one would probably conclude that they belonged to the same species.

Locality, etc.—P.F. 742. Between Roman Rock and Cape Recife. Depth, 17 fathoms. By dredge. Nature of bottom, corals. Date, December 12, 1898.

Family MALACOGORGIIDÆ.

MALACOGORGIA CAPENSIS Hickson.

The colony consists of a main stem (with an expanded, basal, attaching part) which divides at some distance from the base into two primary branches; one of the latter gives rise to three, the other to eleven secondary branches. The polyps are situated on the secondary branches. The main stem is cylindrical and measures 50 mm. in length by 4 mm. in diameter. The basal, attaching part has a diameter of 6 mm. The polyp-bearing branches are long and slender, the longest in my specimens being 80 mm., the shortest 27 mm. in length.

The branches originate in the manner shown in Hickson's figure, coming off right and left in one plane.

There are no polyps at the bases of the secondary branches, thus leaving bare areas, 3–7 mm. in length. The younger polyps are situated near the bases of the branches. The polyps are fully expanded; a large one measures 1 mm. in length and about .75 mm. in diameter. The general appearance of the polyp reminds one superficially of a contracted Hydra. On the lower part of the branches the polyps have a bilateral arrangement, but higher up, and especially near the apices, they originate on all sides and form a dense cluster.

The tentacles are about 0.4 mm. in length and have 12 pairs of pinnules.

The axial part of the secondary branches has a diameter of 0.5 to 1 mm.

I am able to confirm Hickson's statement regarding the absence of spicules in this genus. My specimens are larger than that described by Hickson, and the polyps in his form are also smaller. My specimens, however, agree well with his description.

Hickson gave the following diagnosis of the genus *Malacogorgia* :—

"Colony slightly branched. Axis horny with no trace of lime. No spicules in any part of the colony. Polyps arranged bilaterally in the plane of branching at the basal two-thirds of the secondary branches and on all sides of the terminal one-third of the secondary branches.

"*Malacogorgia capensis*, with the characters of the genus. Colour in spirit, white."

Hickson placed this form in a new family, the Malacogorgiidae. He gave the characters of the new family as follows :—"Colony branched and upright. Axis slender, horny. Spicules and all other forms of calcareous skeleton absent."

Localities, etc. P.F. 18729. Bird Island (near Cape Seal), E. by N. $\frac{1}{4}$ N. 5 miles. By large trawl. Depth, 40 fathoms. Nature of bottom, mud. Date, August 29, 1905.

P.F. 703. Lat. $33^{\circ} 53' 15''$ S., Long. $25^{\circ} 51' 45''$ E. By large trawl. Depth, 26 fathoms. Nature of bottom, mud.

FAMILY PRIMNOIDÆ.

STACHYODES GILCHRISTI, sp. n. (Pl. XLIV. fig. 1; Pl. XLV. figs. 2 a & b.)

The specimens are not complete. The branching is in one plane, but is neither dichotomous nor regular. The polyps are arranged in verticils which are separated from one another by an interval of about a millimetre, but the degree of separation varies considerably at different parts of the colony. There are on an average five verticils to every ten millimetres. The length of a large verticil is about 3 mm. on the ad-axial and 2.5 mm. on the ab-axial side. The verticils are about 5.5 mm. in diameter.

The axis, which is brown on the lower part of the colony and yellow nearer the apex, is covered by sclerites which vary considerably in size and shape. These sclerites covering the horny axis are thin and fairly transparent. The diameter of the axis is about .35 mm.

In each verticil there are usually five polyps. The polyps are protected by three pairs of sclerites, namely an ad-axial pair, a median pair, and an ab-axial pair. The ad-axial pair consists of long sclerites which are produced outwards in a lateral direction, the median pair are smaller. The ad-axial and median spicules have sharp, rather angular margins, and when the latter are viewed from the side, they appear like spines. The ab-axial pair of sclerites have slightly ribbed or dentate margins. The ad-axial sclerites of the two lateral polyps form a ring or tunnel embracing

the main axis. The sclerites vary considerably in size, but they probably range from 0.085×0.153 to 4.0×2.0 mm.

The diameter of a branch in the intervals between the verticils is about 3 mm.

The sclerites covering the axis have the following forms:—(1) triangular, (2) quadrangular, (3) forms with curved sides, and (4) irregular forms.

The systematic position of this species is near *Stachyodes trilepis* Pourtalés and *Calypptrophora josephine* Lindström.

Locality, etc.—P.F. 11966. Cape Vidal (Natal), N.N.E. $\frac{1}{4}$ N. $9\frac{1}{2}$ miles. Depth, 80–100 fathoms. By dredge. Nature of bottom, rocks. Date, February 27, 1901.

THOUARELLA HICKSONI, sp. n. (Pl. XLIV. figs. 3 a & b; Pl. XLV. fig. 1.)

The colony is more or less bottle-brush-like, but it gradually tapers off towards the apex. The dimensions of the colonies vary, the largest specimen was 66 mm. in length and 25–28 mm. in diameter. The central stem gives rise to the polyp-bearing branches in a spiral manner.

These branches vary in length, they are longer near the base of the main stem, and gradually decrease in size towards the apex. The branches are as a rule simple, but in some cases there are secondary and tertiary branches. The primary branches are not arranged in a regular spiral as the distance between their points of origin is not the same in all cases. The interval between the origin of two primary branches on the central stem is frequently about 1 mm.

The axis is horny, flexible, yellow and iridescent, and its surface is covered with imbricating spicules. It is more or less oval in transverse section. When the spicules are removed from the surface of the axis, fine longitudinal lines or striæ are seen. There are generally three spicules in a transverse row on the axis of a branch. The diameter of a branch is about 0.391 mm.; that of the horny axis about 0.136 mm.

Most of the polyps are situated on the primary, secondary and tertiary branches, but sometimes they occur on the central stem. On the branches they originate singly, and are disposed in a spiral manner. The polyps are pear-shaped, and their surfaces are covered by imbricating scales. The size of the polyps varies considerably, the following dimensions may be noted:—(1) 1.088×0.629 mm.; (2) 0.476×0.306 mm.; (3) 1.343×0.595 mm.; (4) 0.595×0.374 mm.; (5) 0.935×0.663 mm.; (6) 0.612×0.391 mm.

The interval on the branches between the polyps also varies but not to any extent. The distance is generally from .5 to .6 of a millimetre. In some polyps, the tentacles were extended beyond the verrucæ, and the pinnules were seen, though not sufficiently well to determine their number. There are on an average about twenty-six spicules on each verruca and these are disposed in six transverse (excluding the opercular spicules) and four or five

longitudinal rows. The spicules of the verrucæ show considerable variation; they may be grouped in two sets, namely (1) those covering the lower or general surface of the verrucæ, and (2) the apical or opercular spicules. The lower spicules of the verrucæ are triangular, rectangular, scale-like or plate-like spicules. In their imbricate arrangement and also in their shape, these spicules remind one of the scales of fishes. Their surface is marked, except near the margin, by a number of small, rounded pores, which are arranged more or less in rows running in the direction of the long axis of the polyp. The margins of these scale-like spicules is frequently, wholly or partially dentate. The opercular spicules situated at the apices of the verrucæ differ in shape from those last described. They are more or less triangular, with a projecting spine in front, the entire spicule resembling a Skate (*Raia*) in form. These opercular spicules are eight in number and their spines project towards the central opening of the verruca. The surface of these opercular spicules have pores similar to those of the lower part of the verruca.

The dimensions of the spicules are as follows:—(a) lower spicules of the verrucæ from 0.1105×0.1615 to 0.187×0.221 mm.: (b) the apical or opercular spicules (including the spine) from 0.289×0.136 to 0.561×0.255 mm.

The spicules covering the main stem of the colony are similar to those of the lower part of the verrucæ, but are frequently much smaller. They have a more or less irregular arrangement and do not as a rule overlap one another. Their size is very variable, ranging from 0.068×0.025 to 0.221×0.153 mm.

Around the basal part of the colony a Polyzoan is encrusted, and intertwined among the upper branches are small Ophiuroids.

Locality, etc.—P.F. 14265. Off Cape St. Francis, N.E. by E. 32 miles. By dredge. Depth, 74 fathoms. Nature of bottom, rocks. Date, February 19, 1902.

Family GORGONIIDÆ.

GORGONIA CAPENSIS Hickson.

This is a beautiful example of a species described by Hickson from the Cape in 1900.

Hickson's specimen is larger, namely 250 mm. in length, while my example is only 140 mm. long.

The spicules are warty spindles ("Doppelspindeln" of Kölliker). The average length of these spindles in Hickson's specimen is 0.1 mm.; in mine they are smaller, namely, from 0.0544×0.034 to 0.0935×0.034 mm.

In 1900 Hickson recorded this species as a viviparous Alcyonarian, and in 1905 Thomson and Henderson corroborated this discovery in specimens from Ceylon.

The Ceylon specimens were collected in deep as well as in shallow water. They were larger than either of the Cape specimens, and were practically white. Hickson's specimen was

collected off Cape St. Blaize, S.W. $\frac{1}{4}$ W. 10 miles, at a depth of 40 fathoms. My specimen was collected farther to the north:—Between Knysna Head and Nutze River, 3 to 4 miles off shore. Depth, 35–49 fathoms. By large trawl. Nature of bottom, sand and mud. The specimen had entangled among its branches, the string-like projections of a “Mermaid’s Purse” and two or three Brittle-stars.

GORGONIA FLAMMEA E. & S.

This species is collected in great abundance on the shore, especially after storms, at many parts of the coast. It is extremely common for example at Gordon’s Bay, False Bay.

Family GORGONELLIDÆ.

SCIRPEARIA FURCATA Hickson, emend. Simpson.

- 1903. *Scirpearia furcata* Hickson.
- 1903. *Scirpearia furcata* var.? Hickson.
- 1903. *Scirpearella indica* Hickson.
- 1905. *Scirpearia* sp., Thomson & Henderson.
- 1905. *Scirpearella* sp. B, Thomson & Henderson.
- 1905. *Juncella elongata* (Val.) Hickson.
- 1909. *Scirpearella aurantiaca* Thomson & Russell.

This species has recently been thoroughly revised by Simpson and I therefore include his list of synonyms. In preparing his valuable monograph on the Juncellid Group of the Gorgonellidæ, Simpson had an opportunity of examining my specimens from South Africa.

The South African localities are as follows:—

- P.F. 13081. Hood Point, N. $5\frac{1}{2}$ miles. Depth, 42 fathoms. Nature of bottom, sand and shells.
- P.F. 858. Off and east of Cape Morgan. Depth, 36 fathoms. Nature of bottom, stones.
- P.F. 12377. Umhlangakulu River mouth, N.W. by N. $7\frac{1}{2}$ miles. Depth, 50 fathoms. Nature of bottom, sand, shells and sponge fragments.
- P.F. 10841. Umhloti River mouth, N. by W. $\frac{1}{2}$ W. $8\frac{1}{2}$ miles. Depth, 40 fathoms. Nature of bottom, sand, shells, and hard ground.
- P.F. 13030. Beacon east of East London, N. $\frac{1}{4}$ E. 10 miles. Depth, 52 fathoms. Nature of bottom, sand and shells.
- P.F. 12033. Cone Point, N.W. $\frac{1}{2}$ W. 4 miles. Depth, 34 fathoms. Nature of bottom, broken shells.
- P.F. 11543. Tugela River mouth, N.W. by N. $22\frac{1}{2}$ miles. Depth, 47 fathoms. Nature of bottom, broken shells.

SCIRPEARIA FLAGELLUM Studer, emend. Simpson.

- 1863. *Juncella flagellum* Johnson.
- 1864. *Juncella flagellum* Johnson.
- 1870. *Viminella flagellum* Gray.

1881. *Scirpearia flagellum* Studer
 1891. *Scirpearia ochracea* Studer.
 1901. *Scirpearia flagellum* Studer.
 1901. *Scirpearia ochracea* Studer.
 1909. *Scirpearia flagellum* Thomson & Russell.

I have quoted the preceding synonyms from Simpson's paper. The following South African localities at which this species occurs, may be noted :—

- P.F. 12855. Buffalo River, East London, N. 15 miles. Depth, 310 fathoms. Nature of bottom, coral and mud.
 P.F. 12061. O'Neil Peak, N.W. $\frac{1}{4}$ W. $9\frac{1}{2}$ miles. Depth, 90 fathoms. Nature of bottom, broken shells.
 P.F. 12107. O'Neil Peak, N.N.W. $\frac{1}{4}$ W. 8 miles. Depth, 55 fathoms. Nature of bottom, broken shells.
 P.F. 11586. Amatikulu River mouth, N.W. $\frac{3}{4}$ N. 20 miles. Depth, 62 fathoms. Nature of bottom, rocks and sponges (hard ground).

HICKSONELLA SPIRALIS Simpson.

Juncella spiralis Hickson.

This species was described from the Cape by Hickson, later revised by Simpson and named *Hicksonella spiralis*. Unfortunately the generic name, *Hicksonella*, is already preoccupied for an entirely different Alcyonarian genus.

Simpson has given the following diagnosis of this species :—“ Colony unbranched; in the larger forms spirally twisted. The cœnenchyma is thin and densely packed with scale-like spicules; the axis is composed of concentric laminae of a horny substance in which a calcareous deposit is embedded. The polyps are restricted to a region occupying two-thirds to three-fourths of the circumference of the cœnenchyma; a longitudinal bare tract occupies the remaining part. The verrucae are long and club-shaped, and are evidently not retractile into the cœnenchyma; they are closely packed together, and are covered with minute overlapping, scale-like spicules. The flat thin scales on the aboral surface of the tentacles form a sort of pseudo-operculum to the partially retracted polyp.

The chief types of spicules are :—(1) In the cœnenchyma, very thick spindles with close-set irregular warts, passing by gradual transitions to almost spherical warty forms: (2) in the polyps, (a) long thick spindles with a few long warts, (b) irregular forms and crosses, (c) small, flat, thin scales.”

Localities, etc.—P.F. 13152 A. Cape Morgan, N. $\frac{1}{2}$ W. $10\frac{1}{2}$ miles. Depth, 77 fathoms. Nature of bottom, rocks and broken shells.

P.F. 13121. Cape Morgan, N.N.E. $9\frac{3}{4}$ miles. Depth, 47 fathoms. Nature of bottom, broken shells.

Hickson's specimens were also collected off Cape Morgan, at a depth of 36 fathoms.

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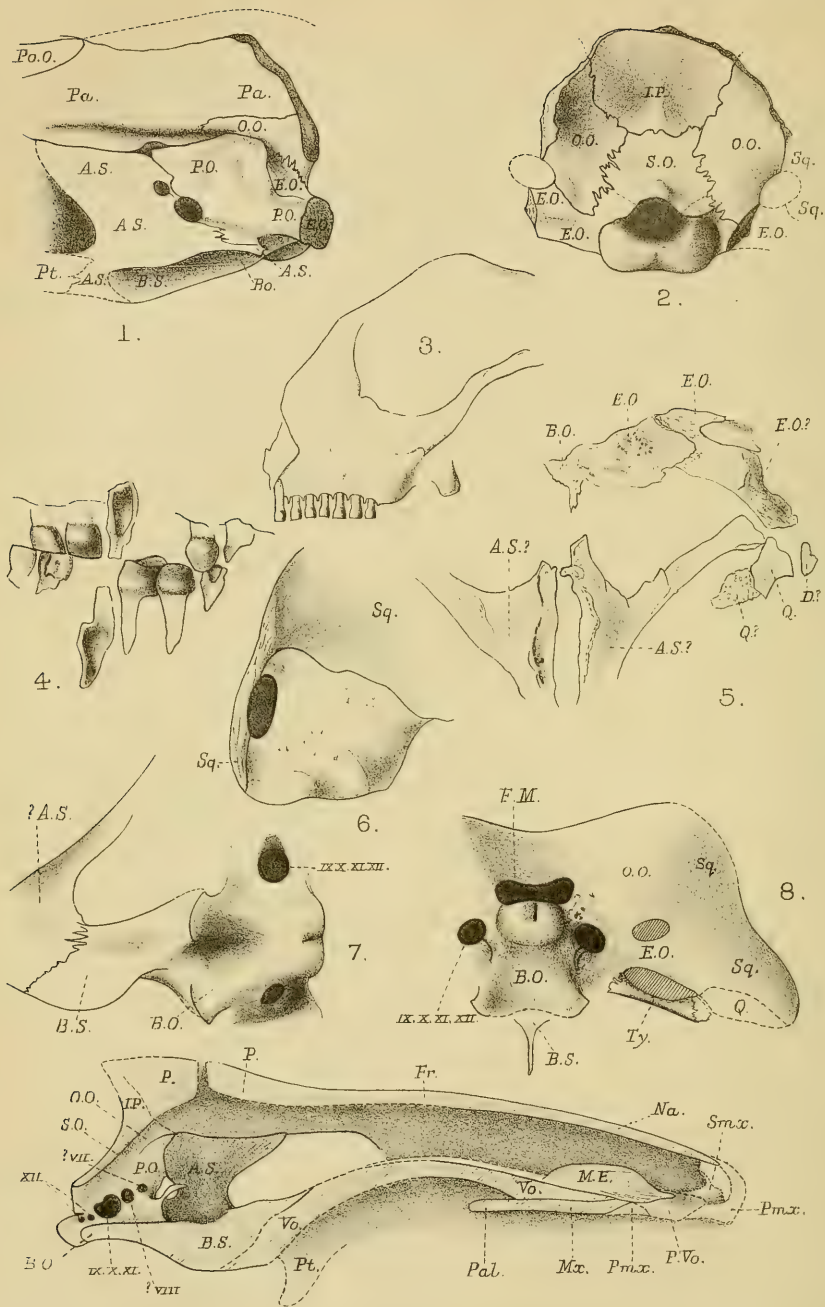
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EXPLANATION OF THE PLATES.

PLATE XLIII.

- Fig. 1. *Ceratoisis ramosa* Hickson. $\times 1\frac{1}{2}$.
 2. *Eunicella papillosa* Esper. Nat. size.
 3. *Eunicella papillosa*, part of branch of (with cephalopod egg-capsule encircling the branch). $\times 6$.
 4. *Suberia capensis*, sp. n. Nat. size.
 5. *Psammogorgia pulchra*, sp. n. $\times 1\frac{1}{2}$.



R.B. del.

9.

Huth lith. et imp.

SKULLS OF CYNODONT REPTILES.

PLATE XLIV.

- Fig. 1. *Stachyodes gilchristi*, sp. n., part of branch of. $\times 8$.
 2 a. *Euplexaura media*, sp. n. Spicules of central trunk.
 2 b. " " " Spicules of external trunk.
 2 c. " " " Spicules of polyps.
 3 a. *Thouarella hicksoni*, sp. n., verruca of. $\times 45$.
 3 b. " " " apex of verruca of. $\times 100$.
 4 a. *Mariceides fusca*, sp. n. Spicules of upper part of polyp.
 4 b. " " " Spicules of lower part of polyp.
 4 c. " " " Spicules of cœnenchyma.

PLATE XLV.

- Fig. 1. *Thouarella hicksoni*, sp. n. Spicules of verruca.
 2 a & b. *Stachyodes gilchristi*, sp. n., sclerites of.
 3 a. *Psammogorgia pulchra*, sp. n., red spicules of.
 3 b. " " " yellow spicules of.
 4 a. *Suberia capensis*, sp. n. Spicules of central trunk.
 4 b. " " " Spicules of external trunk.
 4 c. " " " Spicules of polyp.

38. On the Structure of the Skull in Cynodont Reptiles *.

By R. BROOM, M.D., D.Sc., C.M.Z.S.

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(Plate XLVI.† and Text-figures 168–180.)

Historical and Introductory.

In 1853 the British Museum received from Andrew Bain the first known skulls of fossil reptiles with a mammal-like arrangement of the teeth. These ultimately became the types of *Lycosaurus tigrinus* and *Cynodraco serridens*. In 1858 Sir George Grey presented the skulls which were shortly afterwards described by Owen as *Galesaurus planiceps* and *Cynochampsia laniaria*. The *Galesaurus* skull though crushed was nearly complete, and being so very remarkably mammal-like Owen almost immediately described it in a paper read before the Geological Society on 20th April, 1859.

Although for seventeen years nothing further descriptive of any of the reptiles with a mammal-like dentition was published, it is necessary to briefly consider some of Owen's other work in the interval to clear up a certain confusion of nomenclature. In 1859 Owen gave to the world his famous classification of the fossil reptiles, and though he formed the Order *Anomodontia* for the South African reptiles of the Dicynodont type, he carefully omitted all reference to those reptiles, like *Galesaurus* and *Cynochampsia*, with a mammal-like dentition. When in 1861 he published his 'Paleontology,' feeling compelled to put the remarkable *Galesaurus* somewhere, he made it the type of a "family" of the *Anomodontia*, calling it the *Cynodontia*, doubtless

* On p. 902 Dr. Broom names a new species, viz. *Cynognathus seelyi*.—EDITOR.

† For explanation of the Plate see p. 925.

recognising that *Galesaurus* was in some way related to *Dicynodon*, but hesitating to make a new Order on the evidence of a single skull. As he still defined Anomodontia as reptiles with "teeth wanting or limited to a single maxillary pair," it is manifest he did not regard *Galesaurus* as really an Anomodont.

In 1876, when Owen issued his 'Catalogue of the South African Fossil Reptiles' he put all the forms with a mammal-like dentition into a new Order, the *Theriodontia*. In 1903 I showed that Owen's *Theriodontia* is not a natural order, for it included two groups which, though agreeing in having the dentition specialised into incisors, canines, and molars, and possibly the one being ancestral to the other, were yet so dissimilar that they could not be well kept together. The more primitive group, which occurs only in Permian beds, has simple molars, an open Rhynchocephaloid palate, a transpalatine bone, large angular and surangular bones, a single occipital condyle, no acromion process, and apparently a digital formula of 2, 3, 4, 5, 3. The higher group, which is known only from Upper Triassic beds, has usually specialised molars, a secondary palate as in Mammals, no transpalatine, small angular and surangular bones, two occipital condyles, an acromion process, and a digital formula 2, 3, 3, 3, 3. As Cynodontia was the name first applied to animals of the *Galesaurus* type, this title should be retained for the higher group. For the lower forms I proposed the name *Therocephalia*. The name *Theriodontia* should be dropped, as only likely to lead to confusion.

Among the new forms described by Owen in his Catalogue is a badly weathered small Cynodont skull somewhat resembling that of *Galesaurus* and named *Nythosaurus larvatus*. In 1887 he described another small but well-preserved skull which he believed to be an additional specimen of *Galesaurus*.

Most of our knowledge of the Cynodonts, however, is due to Seeley, who, as the result of his expedition to South Africa, not only came across the skulls of many new types, principally in the collections of Dr. Kannemeyer, Mr. A. Brown, and the Albany Museum, but for the first time obtained most of the skeleton of some Cynodonts. In one paper issued in 1896 he described a very fine skull with most of the vertebral column, the limb-girdles, and portions of the limbs of a large carnivorous type, which he called *Cynognathus crateronotus*, also a fine skull of an allied form called *Cynognathus platyceps* from the Albany Museum collection. In other papers he described new types of Cynodont reptiles with flat-topped molars. Of these the best known types are *Gomphognathus*, *Diademodon*, and *Trirachodon*. These were regarded by Seeley as belonging to a distinct Order, which he called *Gomphodontia*; but as, apart from the specialisation of the molars, there are no characters of any importance to distinguish the Gomphodonts from the Cynodonts, it seems to me impossible to regard them as forming more than a Family of the Cynodontia.

Within the last eight years I have been so fortunate as to come

across a considerable number of new Cynodonts, mostly collected by Mr. A. Brown, and also to add a good many facts to our knowledge of the anatomical structure. Probably the most important of the recent finds has been the discovery by myself of the nearly perfect skull which I have called *Bauria cynops*.

Of all extinct reptilian groups there is probably no one of greater interest than the Cynodontia. Many years ago Owen recognised the remarkable mammalian characters in the Permian and Triassic South African reptiles, and though the Cynodonts were so little known, he ventured to suggest that certain of the Anomodonts were fairly closely allied, and perhaps ancestral, to the Monotremes. Cope held much the same view. When the very much more mammal-like Cynodonts were described by Seeley, many recognised in this higher group the looked for Sauro-Mammalia. Osborn has been the chief advocate of this opinion. Seeley himself, though at first inclining to it, afterwards came to the conclusion that the Mammals were in no way nearly related to the Cynodonts, but sprang from some unknown ancestor that lived in Devonian or Silurian times.

If the Cynodonts are not nearly related to Mammals, the group is still of great interest as showing a marvellous parallelism with the Mammals in skull, teeth, girdles, limbs, and digits; but if, as all recent work seems to indicate still more clearly, the mammalian ancestor was probably a Cynodont, the group becomes vested with an interest altogether unique, and everything bearing on it becomes worthy of the most careful study. I have fortunately been able to examine every known skull, and in the present paper I give the results of my researches. As the paper is morphological rather than systematic, I propose to give a detailed account of the skulls of only the principal Cynodont types, and to consider more fully those points which seem to have a special bearing on the question of mammalian descent.

Bauria.

(Pl. XLVI. figs. 6, 7, 8, and text-figs. 168, 169.)

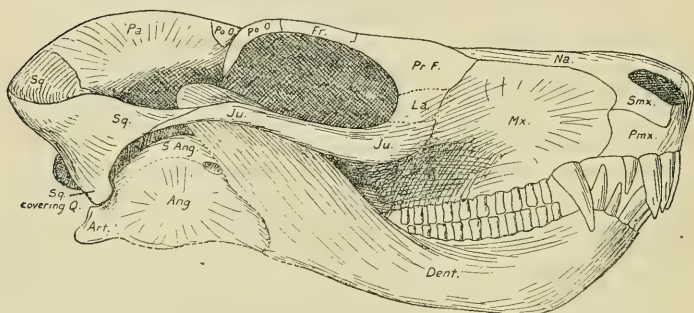
Though *Bauria cynops* occurs in the same horizon as *Cynognathus*, it is the most primitive Cynodont at present known, and may be regarded as the type of a distinct family which may be called the Bauridae.

As I have just recently, at considerable length, described the only known skull of *Bauria cynops*, it will be unnecessary here to do more than supplement that description in a few details and to consider its relationships to the other known Cynodonts, the Therocephalians, and the Mammals.

Further development and examination of the skull has revealed one or two points not previously noted. Under the nostril and forming not only its floor but covering a considerable part of the premaxillary is a large septomaxillary bone. The lachrymal and prefrontal bones cannot in the specimen be clearly separated

from one another, but it is quite manifest that the lachrymal is small and the prefrontal only moderate-sized. The nasal extends well back and forms a broad suture with the frontal. The frontals form the greater part of the interorbital region and most of the supraorbital ridge. There are no postfrontals, and the postorbitals are remarkable in forming only a postorbital process and in not meeting the jugal to form a postorbital arch. The jugal is slender and passes back nearly to the articular region. The portion of the squamosal that supports the quadrate is well developed, but the zygomatic portion is slender.

Text-fig. 168.*



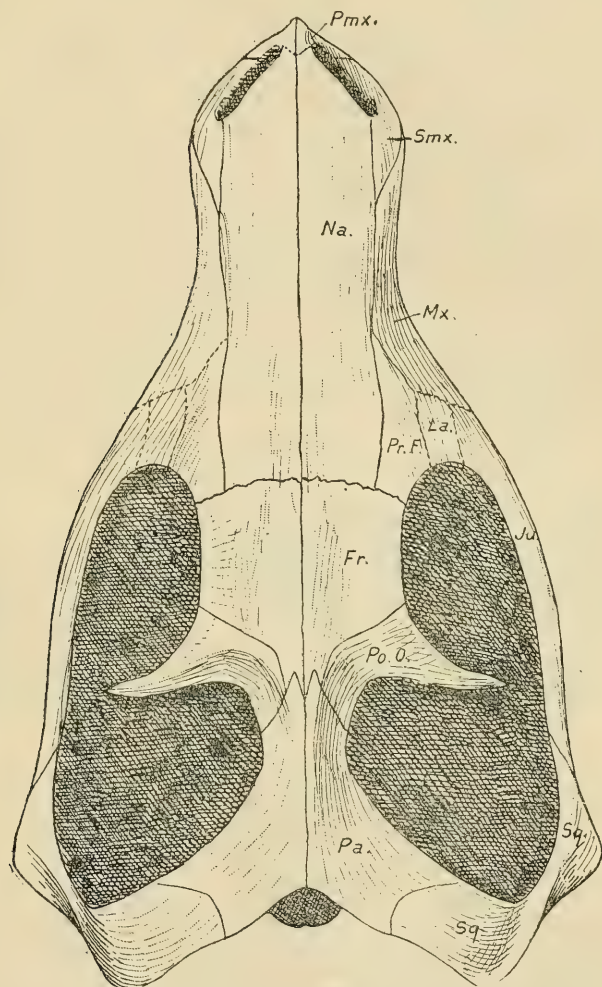
Side view of the type and only known specimen of *Bauria cynops*. Since the specimen was first figured it has been considerably further developed at the British Museum and by myself. The jaws are represented as closed. The molar teeth must meet one another as shown in the figure. When first described the teeth were regarded as round, but further development shows that they are about twice as broad in one diameter as in the other. Though the incisors are mostly broken the impressions of the greater part of each is preserved, and the lower must have met the upper as shown in the figure. The jugal arch is represented in its central part only by the impression, but there is no doubt it must have been practically as restored. It certainly did not meet the postorbital, which is perfectly preserved on both sides. All the sutures shown in unbroken line can be clearly made out.

The palate is as in typical Cynodonts, the secondary palate being as well developed. The vomer, palatines, and pterygoid, so far as can be seen, all are of the ordinary Cynodont type. The lower part of the alisphenoid appears to be of the same type as in higher Cynodonts, articulating with the basisphenoid and passing out to the quadrate. It is just possible, however, that this outward extension may be, as in the Therocephalians, entirely formed by the pterygoid. The basisphenoid is unlike that of either the Anomodonts, Therocephalians, or higher Cynodonts. It is short, with a broad articulation for the basioccipital behind, and a narrow articulation in front for the alisphenoid and probably the vomer. From its under surface there passes down

* For explanation of the lettering in the text-figures see p. 925.

a narrow deep median ridge, which is nearly as deep as the bone is long. The basioccipital resembles considerably that of the Anomodonts in having a pair of short postero-lateral processes

Text-fig. 169.

Upper view of the skull of *Bauria cynops*.

which meet the basisphenoid. The condyle is unique (Pl. XLVI, fig. 8). It is a single condyle, only partly divided into two by a deep median groove. It is thus in type intermediate between the condyle of the Therocephalian and that of the higher Cynodont.

The large foramen for nerves ix., x., xi., and xii. lies by the side of the basioccipital and in front of a bone which is probably part of the opisthotic. Nerve xii. enters the foramen exactly as it does in the higher Cynodonts. On the inside of the skull it has two small distinct canals, which pass forwards and both unite with the large foramen.

The bone which is supposed to be the stapes is shown in fig. 8 (Pl. XLVI). It is apparently a little displaced forwards.

The lower jaw has a fairly large surangular and angular, the dentary being considerably in front of the articular region.

Taking all the characters into consideration, *Bauria* becomes one of the most interesting intermediate types ever discovered. Though an undoubted Cynodont, it retains many of the Therocephalian characters. On the other hand, though on the whole it is less mammal-like than the higher Cynodonts, it has some mammalian characters which the others have lost.

The following are Therocephalian characters usually lost in Cynodonts but retained in *Bauria*:—

1. Large septomaxillaries forming part of the facial surface.
2. Moderate prefrontals.
3. Large frontals forming most of the interorbital region.
4. Feeble zygomatic arch.
5. The two occipital condyles so imperfectly separated as to represent practically a single condyle.
6. Large size of angular and surangular.
7. Shape of the articular.
8. Simple condition of the molar teeth.

In the following characters *Bauria* is nearer to the mammalian ancestor than are the higher Cynodonts:—

1. Large size of septomaxillaries and development on face.
A somewhat similar condition is found in primitive Multituberculata (e. g. *Tritylodon*), also in Monotremata, as shown by Gaupp in *Echidna* embryo.
2. Large frontals.
3. Complete loss of parietal foramen.
4. Absence of postorbital arch.
5. Simple condition of molar teeth.

Nyctosaurus.

(Text-fig. 170.)

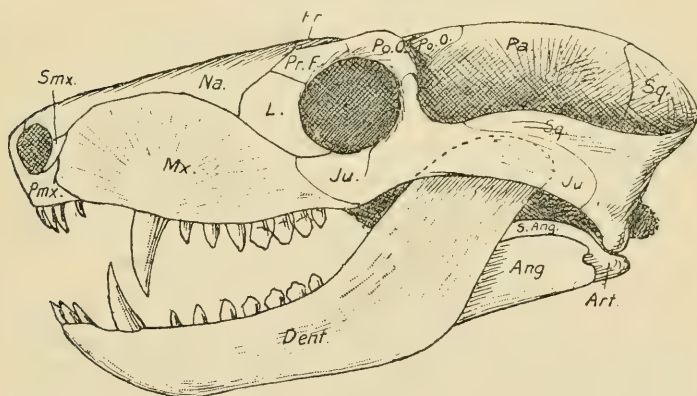
The type of *Galesaurus planiceps* is a somewhat crushed skull with the bones in an unsatisfactory condition for showing sutures. No second specimen of *Galesaurus* has ever been discovered. In 1876 Owen described an imperfect skull as *Nyctosaurus larvatus*. In 1887 he described another skull in fairly good preservation which he believed to be another specimen of *Galesaurus*. Seeley in 1894 showed that this supposed second specimen of

Galesaurus differed greatly from the type, and gave it the name of *Thrinaxodon liorhinus*.

There is, in my opinion, not the least doubt that Seeley was right in regarding the 1887 skull as belonging to a very different animal from the 1859 one. In fact it seems strange that any one should ever have thought them the same. *Galesaurus* has a dental formula apparently of $i. \frac{5}{3}$, $c. \frac{1}{1}$, $m. \frac{12}{12}$; the 1887 specimen has a formula of $i. \frac{4}{3}$, $c. \frac{1}{1}$, $m. \frac{7}{7}$. In the 1859 specimen 10 molars occupy 20 mm.; in the 1887 specimen 7 molars occupy 20 mm. But while the two supposed *Galesaurus* specimens represent different genera, two other imperfect specimens in the British Museum show that the 1887 specimen is the same animal as was described in 1876 as *Nythosaurus larvatus*. Hence the well-known skull which is figured in various text-books as *Galesaurus* must in future be called *Nythosaurus*.

Nythosaurus is a much higher type than *Bauria*; but though it comes fairly close to the higher Cynodonts such as *Cynognathus*, it should, I think, be taken as the representative of a distinct family, the *Galesauridae*. From the various specimens in the British Museum it is possible to make an almost complete restoration of the skull.

Text-fig. 170.



Side view of the skull of *Nythosaurus larvatus*. The drawing is mainly that of the best preserved specimen in the British Museum, compared with the other specimens and slightly restored from them. The teeth are represented in the mature condition.

The septomaxillary though smaller than in *Bauria* still appears on the face. The nasal is large and very broad at its upper end. The lacrymal is large, and though the prefrontal is only of moderate size, it joins with the postorbital and completely shuts out the frontal from the orbit. The postorbital forms with the

jugal a rather feeble postorbital arch. The zygomatic arch is formed by the jugal and the squamosal. The jugal extends nearly back to the articular region, and the squamosal nearly forward to the base of the postorbital arch. The squamosal is not unlike that of *Bauria*, but the zygomatic portion is much better developed; so that as regards the squamosal *Nythosaurus* is intermediate between *Bauria* and *Cynognathus*. The quadrate is of the same type as in the better known *Cynognathus*.

The palate, so far as known, agrees fairly well with the *Cynognathus* type, and the occipital condyle is double.

The lower jaw has a large dentary, but there is no trace even of a condylar process. The angular and surangular are fairly large and still resemble considerably the Therocephalian type. The articular also resembles that of the earlier rather than that of the later types.

Nythosaurus is perhaps the most mammal-like of the known Cynodonts. The zygomatic arch is exceedingly like that of most primitive mammals, and if the prefrontal and postorbital bones were lost and the internasal process of the premaxilla aborted there would be nothing left in the side view of the skull to distinguish it from that of a mammal. The lower jaw with its fairly large angular and surangular is still much less like the mammalian condition than what we see in the higher Cynodonts, and the articular is of the same primitive type seen in *Bauria*.

The dentition though very primitive is considerably more highly evolved than in *Bauria*. The formula, i. $\frac{4}{3}$, c. $\frac{1}{1}$, m. $\frac{7}{7}$, comes very near to that of the typical mammal, and that of *Galesaurus*, i. $\frac{5}{3}$, c. $\frac{1}{1}$, m. $\frac{12}{12}$, is near that of the ancestral mammal. The difference in the teeth in some of the specimens of *Nythosaurus* is apparently due to the fact that in some the teeth belong to the first set and in others to the second.

Cynognathus.

(Pl. XLVI. figs. 1 & 2, and text-figs. 171, 172.)

The genus *Cynognathus* is known by the very fine skull of *C. crateronotus* in the British Museum, the type skull of *C. platyceps* in the Albany Museum, a fairly good skull of *C. berryi* in the S. African Museum, and three or four less satisfactory specimens.

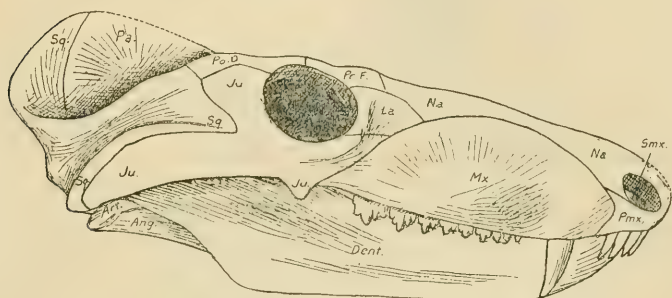
Seeley has given a fairly full account of the skull of *Cynognathus crateronotus*, but unfortunately a number of his figures are so indifferently reproduced that they convey no more to the student than does the plaster cast. And further, while most of his determinations are correct, he unfortunately suggests so many alternative possibilities that the morphologist is left comparatively helpless.

The figure given by Seeley of the side view of the skull of *C. crateronotus* gives an excellent idea of the general form of the skull and of the structure of the temporal region, except that the

supposed perforation in the zygomatic arch is, in my opinion, not a natural feature and has been produced post mortem. The side view which I give of the skull of *C. platyceps* is fairly similar, except that the skull is here much broader and flatter, and in this species, at least, there is no trace of an opening in the zygoma.

The snout of *Cynognathus* differs from that of *Bauria* and *Nyctosaurus* chiefly in the fact that the septomaxillary does not appear on the face, though it can be readily seen within the nostril.

Text-fig. 171.



Side view of the skull of *Cynognathus platyceps*. With the exception of the front of the snout the drawing is made from the very fine type skull in the Albany Museum. The front of the snout is from the specimen described by Seeley as ? *Cynognathus leptorhinus*. As I showed some years ago, this is unquestionably the snout of a nearly full-grown specimen of *Cynognathus platyceps*.

The premaxilla is relatively rather larger than in *Nyctosaurus*, while the maxilla is about equally well developed in the two genera. The canine is, however, much further forward in *Cynognathus* than in the smaller genus.

The nasal bone is fairly similar in the two genera, being broad both in front and behind and narrow in the middle.

The lachrymal extends further forward than in *Nyctosaurus*, the portion showing on the face being nearly as large as the orbit.

The prefrontal is a long narrow bone which forms the greater part of the upper margin of the orbit, and by meeting with the postorbital completely shuts out the frontal from the orbital margin.

The frontals are each about four times as long as broad. In front they meet the nasals. Laterally they are in contact with the prefrontals and postorbitals. Posteriorly they taper away to narrow points, which meet the anterior ends of the parietals.

The postorbital is a large triangular bone. In front it meets

the prefrontal and forms part of the orbital margin. Externally it gives a large articulation to the jugal and a small articulation to the squamosal. Internally it overlaps the parietal for only a very short distance.

The jugal is relatively considerably larger than in *Nyctosaurus*. Anteriorly it meets the maxilla and lachrymal, but extends further forward than in either *Nyctosaurus* or *Bauria*. Immediately below the orbit there is a small but very distinct tubercle. The ascending process of the jugal is unusually broad and forms a large articulation with the postorbital, the two together forming a very strong postorbital arch. The posterior portion of the jugal extends to the articular region.

The parietal is a narrow bone which forms a low median crest. There is a small pineal foramen.

The squamosal is the largest bone in the skull, with the exception of the dentary. The inner and posterior portion forms nearly the whole of the back wall of the temporal fossa, and has a large articulation with the parietal. This back portion of the squamosal is very thin and is closely united with the flat upper expansion of the opisthotic. The squamosal forms the outer wall of the lateral occipital foramen. Inferiorly it meets the exoccipital and on passing outwards supports the small quadrate. The zygomatic portion is much larger than in *Nyctosaurus*, articulating with the whole of the upper side of the posterior limb of the jugal and meeting the postorbital. There is a deep groove along the middle of the back part of the zygomatic portion, which curves downwards and inwards, and, most probably, the posterior part was for the support of the external auditory canal.

The occiput is best known from the specimen of *Cynognathus berryi* in the S. African Museum, which though imperfect shows the sutures very distinctly. The large occiput figured by Seeley* (p. 130) and doubtfully referred by him to *C. berryi*, is, in my opinion, considerably too large. It also differs from the known occiput of *C. berryi* in the shape of the foramen magnum, the slope of the exoccipitals, and the moulding of the interparietal region. It is pretty clearly not the occiput of *C. crateronotus*, while it is much too large to be that of *C. platyceps*. As it thus seems to belong to a new species, it may appropriately be named *Cynognathus seeleyi*.

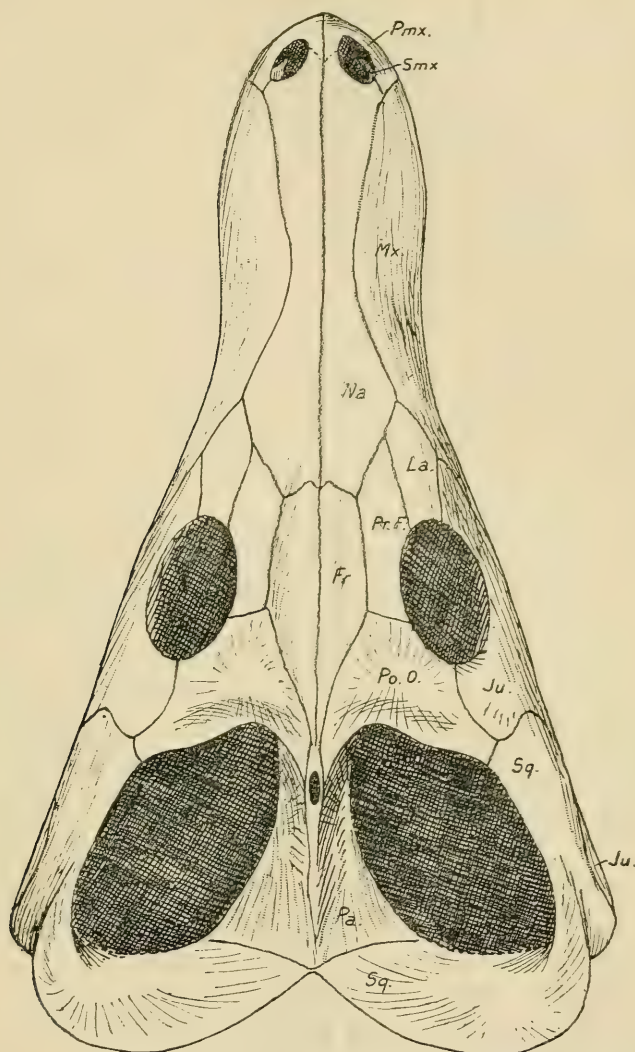
The occiput proper (Pl. XLVI. fig. 2) is made up of seven bones, or, if we include the squamosals, nine. About a quarter of the occiput proper is formed by a median bone, which is apparently the interparietal. I have not seen any specimen which enables me clearly to differentiate this bone from the parietal in front, but, judging by analogy and by the direction of the fibres of the bone, the probability seems much in favour of its being a distinct interparietal.

On either side of the interparietal is articulated a large bone, which is apparently the opisthotic. Its occipital portion is comparatively thin and to a considerable extent covered in front by

* Phil. Trans. Vol. clxxxvi. B. (1895).

the squamosal and parietal. Inferiorly it articulates with the exoccipital and to a large extent with the supraoccipital. It

Text-fig. 172.



Upper view of the skull of *Cynognathus platyceps*.
From the same specimen as text-fig. 171.

forms the upper and inner wall of the lateral occipital foramen, and passes well forward below the edge of the parietal and appears to articulate with the large prootic.

The supraoccipital is completely ankylosed to the exoccipitals, but its probable limits are indicated in the figure given. Immediately above the foramen magnum is a small rounded bony knob.

The exoccipitals form the greater part of the occipital condyles, which are remarkably mammal-like. Above each condyle is a narrow fissure or groove leading into the foramen magnum, but it seems too small to have been for the transmission of either an artery or a vein, and most probably it was not for a nerve. Possibly it is merely owing to the elevation of a portion of the bone for the attachment of a ligament. The exoccipital passes out a considerable distance under the lateral foramen and articulates with the squamosal.

The quadrate is well shown in Seeley's figure 8. It is a relatively small bone, which is firmly fixed on to the squamosal by the main part being in front and two long processes being behind its lower projection. Referring to the posterior delicate processes Seeley says: "I am unable to affirm that they represent auditory ossicles." They are unquestionably parts of the quadrate and have nothing to do with the auditory function. The quadrate forms the greater part of the articular surface for the lower jaw, but not the whole of it, part of the squamosal also forming a portion of the articulation. This is particularly interesting in view of the fact that in the Monotremes the lower jaw hinges directly on the squamosal bone.

The palate of *Cynognathus* is nearly wholly known, the only points concerning which we are still ignorant being the relations of the bones round the anterior palatine foramina, the nature of the middle part of the basicranium, and the relations of the palatine and pterygoid to the jugal.

There is a large secondary palate formed by the maxillæ and palatines exactly as in Mammals. In a recent paper Seeley describes what he believes to be teeth on the palate of *Cynognathus*. I have, however, had an opportunity of examining Seeley's specimen and believe the supposed teeth to be merely irregularities of the bony surface, possibly pathological. Certainly in the other specimens I have examined there is no trace of anything like teeth. The hard palate ends in the middle line opposite the front of the third last molar.

The pterygoids are large and have well-developed pterygoid processes, which lie close along the inside of the jaws as in reptiles generally. There is no transpalatine or ectopterygoid bone. Instead of, as in most reptiles, the pterygoid having a posterior process which extends to the quadrate, it here ends near the middle of the inner wall of the temporal fossa, the posterior continuation which looks like pterygoid being really part of the alisphenoid bone.

The vomer is a large median bone which posteriorly lies between the two pterygoids. In front it forms a vertical plate which supports the secondary palate exactly as in Mammals and extends to near the front of the snout.

The alisphenoid bone is one of the most interesting bones in the skull. It is a large flat bone which extends from the pterygoid below to the parietal above. It is well seen in the type skull of *Cynognathus crateronotus*, but even better in the Capetown specimen of *C. berryi* (Pl. XLVI. fig. 1). The upper portion of the bone is irregularly quadrilateral. The upper side articulates with the parietal, and the posterior with what I believe to be the prootic. Between the alisphenoid and the prootic are two large oval foramina. At the posterior and lower corner the alisphenoid is continued as a slender bone to the quadrate. At its anterior and lower corner it meets the pterygoids and clasps the basisphenoid. There appears to be an opening into the brain-cavity between the base of the alisphenoid and the basisphenoid.

The basisphenoid is clasped by the alisphenoids and meets the basioccipital posteriorly.

The basioccipital is a small bone lying behind the basisphenoid. It forms the middle part of the occipital condylar region. On each side there is a large round foramen which is pretty certainly the foramen for the exit of nerves ix., x., xi., and xii.

Between the outer part of the basioccipital and the quadrate there stretches a rounded pillow-like bone concerning which there may be some difference of opinion. I believe it to be the stapes, for reasons which will be stated later.

The lower jaw is remarkable for the great size of the dentary, which posteriorly nearly reaches the articulation. Elsewhere I have dealt at some length with the structure of the jaw. The splenial is long and slender. The surangular and angular are also feeble splint-like bones. The articular is fairly well developed but short. I cannot satisfy myself that there is a distinct coronoid bone as is stated by Seeley.

The only points in which the *Cynognathus* skull is nearer to the mammal than that of *Bauria* and *Nythosaurus* are: (a) the closer approach of the jugal to the articulation, (b) the greater development of the dentary, (c) the greater reduction of the angular and surangular, and (d) the more mammal-like occipital condyle. On the whole it is not so near the mammalian ancestor as either *Bauria* or *Nythosaurus*.

The dental formula appears to be i. $\frac{4}{3}$, c. $\frac{1}{1}$, m. $\frac{9}{3}$.

Trirachodon.

(Text-figs. 173 & 174.)

Trirachodon is best known by the type skull which is in the Albany Museum. Though the skull is immature and much crushed it is practically perfect. Two or three other known skulls though imperfect show the uncrushed condition of the greater part of the adult skull.

The premaxilla is smaller than in *Cynognathus*, not meeting the nasal behind the nostril, at least not on the face.

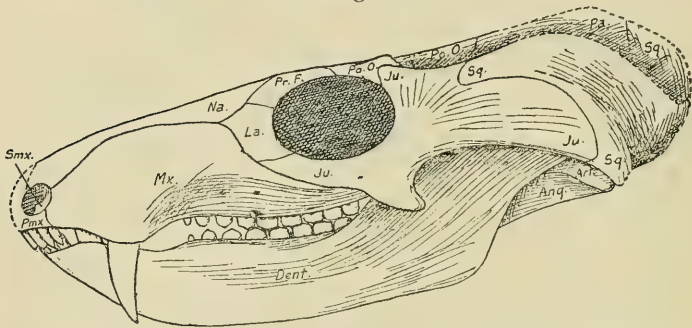
The septomaxillary is entirely in the nostril, forming no part of the face.

The maxilla is long and extends far back below the orbit. The snout is fairly broad at the root of the canine and along the upper part of the maxilla, but is much narrowed in the molar region. There are two foramina for the maxillary branch of nerve v.

The nasal is moderately broad in front, narrow in the middle, and very broad behind.

The lachrymal is small, but forms most of the anterior wall of the orbit.

Text-fig. 173.



Side view of the skull of *Trirachodon kannemeyeri*. The drawing is chiefly founded on the crushed and immature skull which forms the type. Two mature and uncrushed but imperfect skulls in the Albany Museum and a good snout in my own collection have made it possible to correct the crushing of the type and completely restore the skull in the adult condition.

The prefrontal is about twice as long as broad, and forms most of the upper margin of the orbit; it unites, as in *Cynognathus*, with the postorbital, completely shutting out the frontal from the orbital margin.

The frontal is fairly like that of *Cynognathus*, but it does not extend so far forward. Posteriorly, as in the former genus, it tapers away between the postorbitals.

The postorbital is more like that of *Nythosaurus*. It forms the upper third of the postorbital arch, uniting with the jugal. It extends backwards on the side of the parietal a little beyond the pineal foramen.

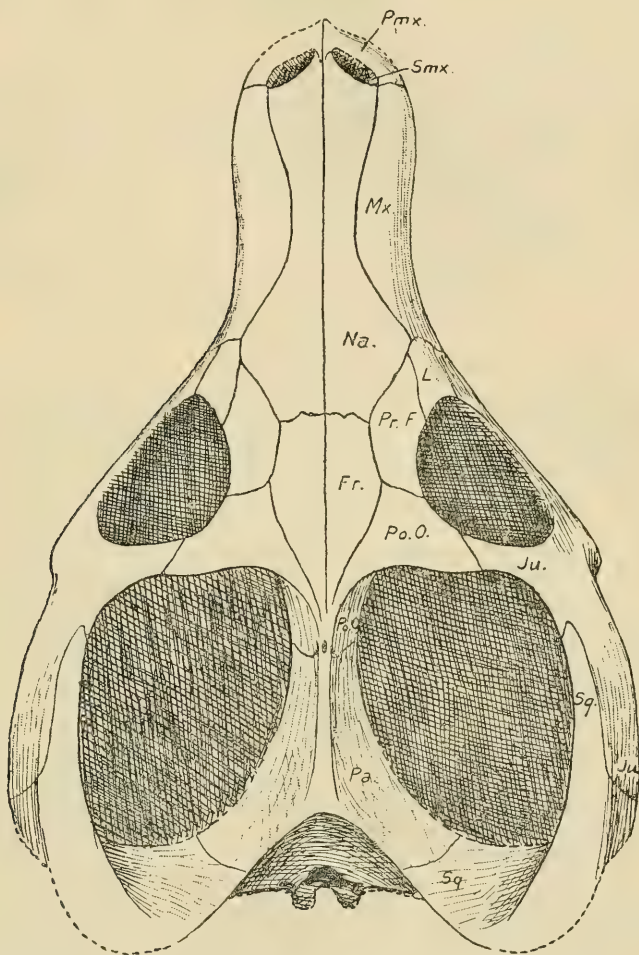
The parietal is like that of *Cynognathus*, but the pineal foramen is much smaller.

The jugal is, on the whole, like that of *Cynognathus*. It has, however, the inferior process much better developed. It forms the lower and posterior half of the orbital margin.

The squamosal differs from that of *Cynognathus* in not meeting the postorbital, but ending in front above the jugal, very much as

in *Nythosaurus*. As the back of the skull is relatively narrower than in *Cynognathus*, the posterior part of the squamosal differs considerably in contour.

Text-fig. 174.

Upper view of the skull of *Trirachodon kannemeyeri*.

From the same specimens as fig. 173.

The quadrate, so far as can be seen, is small but not unlike the better known types.

The stapes is a very slender straight bone about the thickness

of a pin, and having similar relations to the stapes in *Cynognathus*.

The occiput is not well known, but is apparently very similar to that of *Cynognathus*.

The lower jaw has a very large coronoid process and a condylar process which nearly reaches the articulation. The articular, angular, and surangular are on the whole very similar to those of *Cynognathus*.

One of the most striking points of difference from *Nythosaurus* and *Cynognathus* is in the structure of the molar teeth, which have flattened tops, and the lower molars instead of passing inside of them, as in these other genera, meet them much in the same way as do the molars in Mammals.

The dental formula is the same as in *Cynognathus*, viz.:
 $i. \frac{4}{3}, c. \frac{1}{1}, m. \frac{9}{9}$.

Diademodon and *Gomphognathus*.

(Pl. XLVI. fig. 9, & text-figs. 175-178.)

Diademodon resembles *Gomphognathus* so closely, differing only in size and in the number of molars, that there is some reason for suspecting that *Diademodon* may be an immature *Gomphognathus*. If this turns out to be the case, the genus must take the earlier name *Diademodon*. The following description of a skull is based on a beautifully preserved skull in the British Museum, which may be called *Gomphognathus minor*, but which unfortunately has lost the snout, on a fairly good skull of *D. mastacus* in the South African Museum, on two other good skulls of *Gomphognathus* in the British Museum, and on the type skull of *Gomphognathus kannemeyeri* in the Albany Museum. As the result of the examination of this very fine material, the *Gomphognathus* skull is better known even than that of *Cynognathus*, and almost as well as that of the living *Ornithorhynchus*.

The premaxilla is fairly large, but, as in all other Cynodonts, considerably overlapped by the front of the maxilla. It has a strong internasal process, and forms the anterior and most of the lower border of the nostril. It has a very considerable palatal development, the two bones meeting in the middle line behind the anterior palatine foramen.

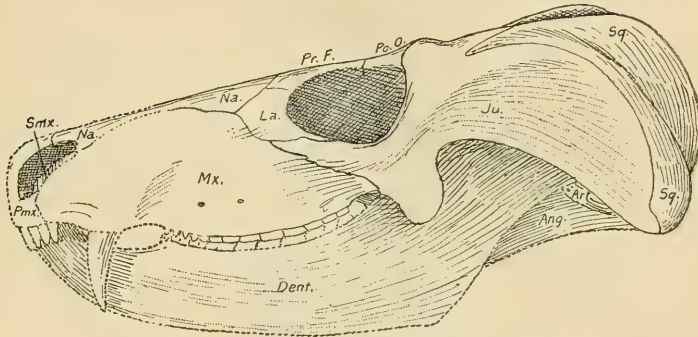
The septomaxillary is well developed, lying along the greater part of the outer wall of the nostril. Most of it is within the nostril, but a small part of the upper end appears on the face.

The maxilla is not unlike that of *Trirachodon*. The maxillary branch of nerve v. has two foramina. On the upper part of the maxilla close to the nasal is a small oval depression, presumably for the lodgment of a gland.

The nasal is narrow in front but broad behind. The nostrils look more upwards than in any of the previously described Cynodonts, and the nasal passes forward between them to a narrow process.

The lachrymal is of fair size. In *Gomphognathus minor* it forms the front of the orbit and much of the inner wall. In *Gomphognathus polyphagus* it is considerably larger, extending to part of the upper margin.

Text-fig. 175.



Side view of the skull of *Gomphognathus minor*. With the exception of the front half of the snout and the lower jaw, the drawing is from the beautifully preserved type in the British Museum. The front of the snout is restored from a specimen of *Gomphognathus kannemeyeri* in the British Museum, and the lower jaw is from the lower jaw of the type of *G. kannemeyeri* in the Albany Museum. Both these latter are slightly modified to fit the skull of *Gomphognathus minor*.

The prefrontal forms most of the upper margin of the orbit. In *Gomphognathus polyphagus* it is considerably smaller than in *G. minor*, owing to its being encroached on by the larger nasal and lachrymal. By uniting with the postorbital it completely shuts out the frontal from the orbital margin.

The frontal is relatively small, the two together forming only about one-third of the interorbital space. As in all the other Cynodonts except *Bauria* and *Sesamodon*, the frontals posteriorly taper away to a point between the postorbitals.

The postorbital is a fairly large bone with an external limb which meets the jugal, forming the postorbital arch, and a posterior process which lies along the parietal. In *G. polyphagus* the postorbital bar is relatively slenderer than in *G. minor*.

The jugal is very large. It is essentially similar to that of *Trirachodon*. The inferior process is much larger and the posterior extension much deeper. It passes backwards some distance behind the plane of the quadrate.

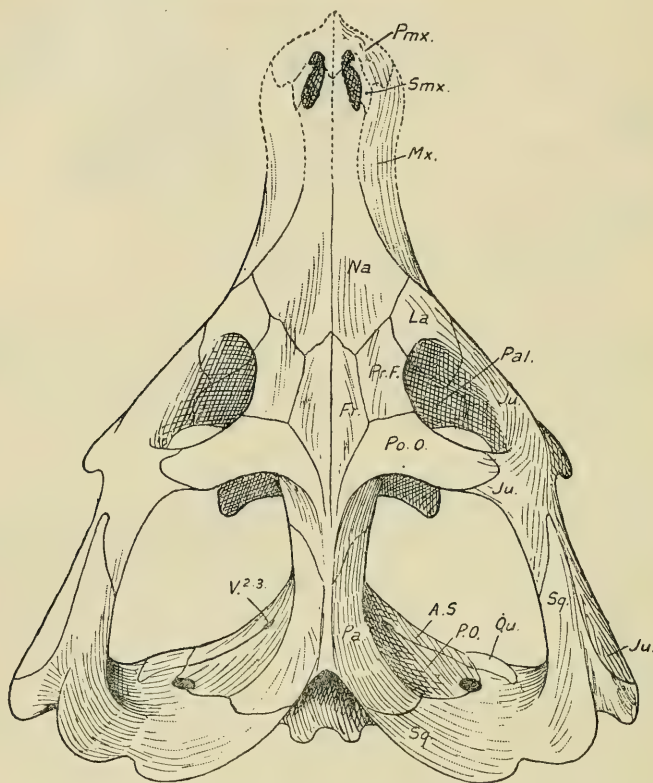
The parietal is small and there is a small pineal foramen.

The squamosal is extremely large. The inner portion articulates with the parietal. The outer and anterior portion lies above the jugal, forming with it a powerful zygomatic arch. Inferiorly the squamosal supports the small quadrate. The peculiar shape of the bone can best be understood from the figures.

The occiput is very similar to that of *Cynognathus*, but the limits of the various elements are less satisfactorily known. The condyle is double, but is relatively smaller and less mammal-like than in *Cynognathus*.

The palate is beautifully shown in three of the British Museum specimens.

Text-fig. 176.

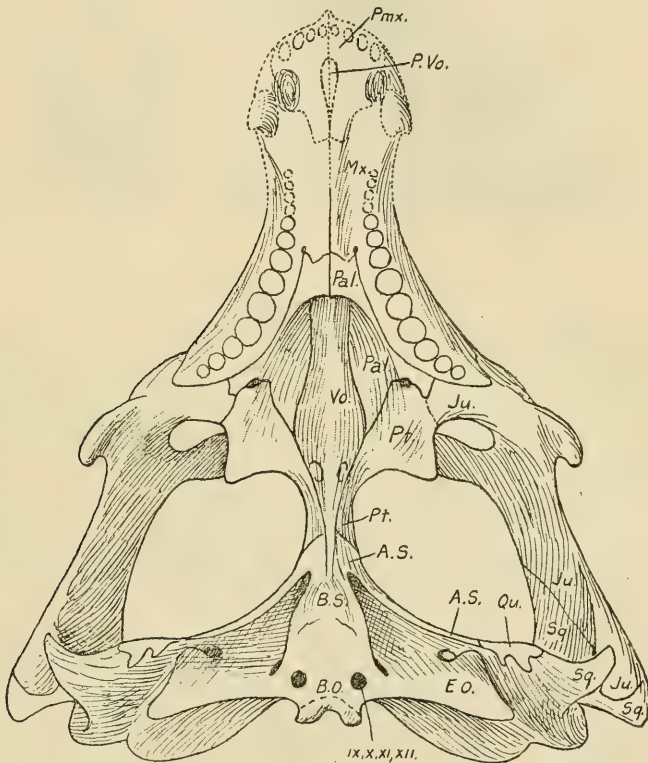


Upper view of skull of *Gomphognathus minor*.
The snout restored from *Gomphognathus kannemeyeri*.

In the anterior palatine opening there is a pair of narrow bones showing what I suggested a good many years ago were probably prevomers. Only one specimen is known in which they are shown. They are evidently not parts of the premaxillæ, and as they are in position exactly corresponding to the prevomers of *Ornithorhynchus*, I am still of opinion that they correspond to the paired vomers of most reptiles and the prevomers of *Platypus* and of *Miniopterus*.

The secondary palate is almost typically mammalian, the maxillæ and the palatines having the same relations as in the mammal. The palatine besides forming part of the secondary palate curves round inside of the maxilla, forming the outer wall and part of the roof of the posterior nares. There is a posterior palatine foramen situated exactly as in Mammals.

Text-fig. 177.



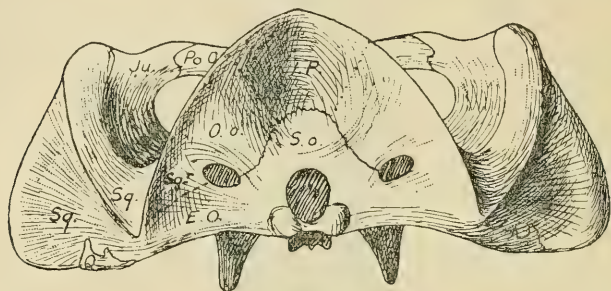
Under view of skull of *Gomphognathus minor*.
The snout restored from *Gomphognathus kannemeyeri*.

The vomer is large and, as in typical Mammals, it forms the median support of the basicranial axis from the sphenoidal region to near the front of the nose. It forms about one-third of the roof of the pharynx, and two small tubercles on its posterior part are probably for the attachment of pharyngeal muscles. In the region of the secondary palate the vomer forms for a considerable distance a median support.

The pterygoid is of moderate size, but much smaller than in any

other reptilian group. In front it meets the jugal and the palatine and lies along the outer side of the vomer. It forms a large descending pterygoid process. Posteriorly it lies against the vomer and terminates by meeting the alisphenoid as in *Cynognathus*.

Text-fig. 178.



Posterior view of skull of *Gomphognathus minor*.

The basioccipital, basisphenoid, and exoccipital are all apparently very similar to those bones in *Cynognathus*. There is a large foramen for the exit of nerves ix., x., xi., and xii. Outside of this foramen, but further from the base, is another foramen which I believe to be the fenestra ovalis, but this is less certain than the nature of the larger foramen, about which there is no doubt.

The alisphenoid in all its relations is very similar to that in *Cynognathus*. At its lower end near where it meets the pterygoid is an opening which leads into the brain-cavity, and most probably it was by this opening that the internal carotid artery entered the cranium.

The quadrate is relatively rather smaller than in *Cynognathus*, but is fixed into the squamosal bone in a very similar fashion. It clasps the lower margin of the bone, and posteriorly it has two processes which fit into grooves. In the type specimen of *Gomphognathus kannemeyeri*, where the articulars do not fit on to the quadrates, I thought the quadrates had been displaced, but I am rather inclined to think it is the articulars, as the London specimens show that the quadrate is not likely to be readily disarticulated.

In the median section of the skull (Pl. XLVI. fig. 9) a number of most interesting features are revealed. In the posterior cranial region there are seen the foramina for the exit of a number of the cranial nerves. Close to the occipital condyle are two small foramina for nerve xii. These after passing a short distance through the bone open into the large foramen lacerum posticum. This large foramen is also situated well back and doubtless transmitted also nerves ix., x., and xi. In front

of this foramen jugulare is the prootic bone, which appears to have two foramina in it. The posterior I believe to be for nerve viii., and the anterior for vii. Between the prootic and the large alisphenoid is seen the opening for probably both the 2nd and 3rd branches of nerve v. Immediately below this foramen, the prootic sends a sharp bony process upwards, inwards, and forwards. Probably it lay on the inner side of the Gasserian ganglion.

The basisphenoid is a large bone, along the front of which lies the back part of the vomer. There is no orbito-sphenoid and no presphenoid bone.

The vomer passes from the basisphenoid to about the middle of the hard palate. Along its dorsal surface ran the cartilaginous cranial axis, against which the grooved upper surface of the vomer fits. At the front of the vomer the median cartilage is ossified, and the bone is apparently the homologue of the mammalian mesethmoid. In the figure given of the median section the prevomer (*P.vo.*) and the septomaxillary (*S.m.x.*) are largely hypothetical.

Sesamodon and *Melinodon*.

(Pl. XLVI. figs. 3, 4, & 5, and text-figs. 179, 180.)

These two allied genera, which are both unfortunately very imperfectly known, stand at present by themselves some distance apart from the other Cynodonts. Each genus is known only by a single specimen, which in the case of *Sesamodon browni* is only fair, and in the case of *Melinodon sinus* very poor. Still the interest attaching to the specimens is so very great that it is necessary to figure them as fully as possible.

Though the only known skull of *Sesamodon browni* is very badly weathered and considerably crushed, it is fortunately possible to restore the external appearance with much certainty. In fact the only points in the external anatomy that remain in doubt are the articular region, the middle of the occiput, and parts of the jugal, frontal, parietal, and squamosal bones.

The premaxilla is not very satisfactorily preserved, but presents no unusual features.

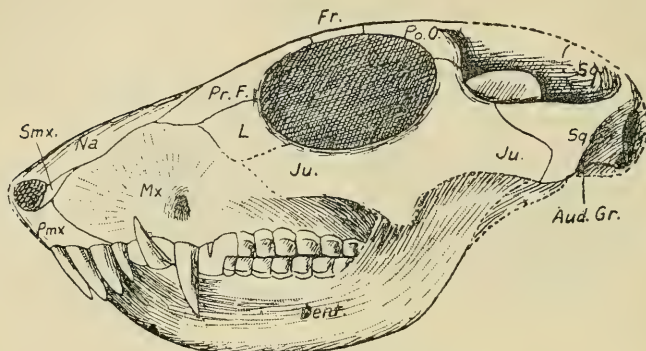
The septomaxillary is apparently fairly similar to that of *Nythosaurus*, appearing on the face to a considerable extent.

The maxilla is large and resembles to some extent that of *Trirachodon*, while in other respects it is nearer to *Nythosaurus*. The canine is relatively smaller than in either *Trirachodon* or *Nythosaurus*, but is situated, as in *Nythosaurus*, far back from the front of the bone. The molars, with the exception of the 1st which is small, form a uniform series, and the maxillary bones are much approximated in the molar region, as in *Trirachodon*.

The nasal resembles on the whole that of *Bauria*. The nostril is directed mainly forward and the nasal to some extent overhangs it. The bone is moderately broad throughout its whole

length, but is chiefly remarkable in being narrower behind than in front. In all other Cynodonts except *Bauria* the nasal is, as in Marsupials, much broader posteriorly.

Text-fig. 179.



Side view of skull of *Sesamodon browni*. Somewhat restored from the only known specimen, which forms the type. The whole of the preorbital portion of the skull except the front of the premaxilla is preserved in the specimen, though the bone in parts is weathered off, leaving only the impression. Though the teeth are imperfect, remains or impressions of all are present, so that the full dentition can be restored with much certainty, the only doubt being the exact length of the incisors and canines. The orbit and the temporal fossa are satisfactorily preserved, and the squamosal is fairly well preserved on the right side of the skull. The lower border of the jugal is unknown. Both mandibles are in position but much weathered. The horizontal ramus is fully known, but much of the ascending ramus is lost. As, however, the top of the coronoid process is preserved in position, the greater part of the dentary can be restored with certainty. The condylar process is badly preserved. A considerable part of what is believed to be the angular and probably part of the articular are preserved. As the position of the glenoid cavity is known, the general shape of the back of the jaw can be restored with some probability.

The lachrymal is small and completely separated from the nasal by the prefrontal. In this, *Sesamodon* again agrees with *Bauria* and differs from all other known Cynodonts.

The prefrontal is much larger than the lachrymal and meets the frontal, nasal, maxilla, and lachrymal as in *Bauria*.

The frontal is almost completely lost from the specimen, but just sufficient of the impression of the bone is left to show that it reached the orbit as in *Bauria*. In this also, *Sesamodon* differs from almost all other known Cynodonts.

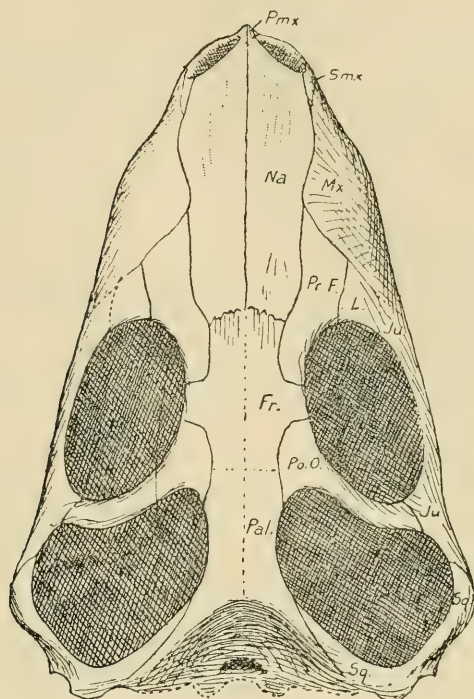
The postorbital is fairly large but slender. It forms with a small part of the jugal a complete postorbital arch. It only extends backwards on the parietal a very short distance.

The parietal is completely lost except just sufficient to show the width of the bone.

The jugal is not well preserved except in the upper part. It forms the whole of the lower orbital margin and part of the

postorbital arch. In the drawing given the lower margin is entirely hypothetical. The posterior or zygomatic portion of the bone is very short.

Text-fig. 180.



Upper view of skull of *Sesamodon browni*, restored from the type. From the specimen the whole of the frontals, parietals, and most of the occiput have weathered away, so that these parts are unknown. As, however, the prefrontals, postorbitals, and the margins of the orbits and temporal fossæ are preserved, the only points that are left in doubt are the position of the fronto-parietal suture, whether there is a parietal foramen, and the nature of the condyles.

The squamosal is sufficiently well preserved to show its main features, and it is seen to be unlike that of any other Cynodont. As in *Bauria* it is much smaller than in the higher types. It articulates, as in other forms, with the parietal, but on passing outwards it has not, as in *Bauria*, a posterior ridge. The zygomatic portion is much shorter than in *Bauria* or any other known type, but it is relatively fairly deep.

What appears to be the quadrate is a small flattened bone which I have shown in the figure, but the parts are crushed and somewhat displaced, and it is impossible to speak with certainty of the condition.

The occiput is badly preserved, but is remarkable for the great lateral extension of the exoccipital, which passes out behind and below the squamosal. Owing to some degree of crushing it is difficult to be quite sure of the relations of the external end of the exoccipital, but it certainly extends much further out than in any other known Cynodont.

The palate, so far as preserved, differs considerably from that of the typical Cynodonts. There is a secondary palate of the ordinary type, but the pterygoid appears to have a larger pterygoid process than usual. Behind the pterygoid process there is a fan-like bony expansion which passes backwards and outwards towards the articular region. It looks as if it might be all pterygoid, but owing to the crushed and weathered condition of the specimen it is impossible to be sure. Possibly, as in the typical Cynodonts, it is part of the alisphenoid.

The structure of the lower jaw cannot be satisfactorily made out. The dentary has a very large coronoid process; in fact the coronoid process is as large as the horizontal ramus. There also is some evidence of a condylar process. The articulation is apparently, mainly at least, formed by a rounded articular supported by possibly an angular and surangular. There is a well-developed splenial bone.

The dental formula is $i. \frac{4}{3}, c. \frac{1}{1}, m. \frac{7}{7}$.

Melinodon is closely allied to *Sesamodon* and pretty certainly belongs to the same family. The teeth are of the same type, but relatively much smaller. The specimen is so imperfect that it is impossible to make much of the skull. I have figured it as preserved (Pl. XLVI. fig. 3).

Sesamodon resembles *Bauria* and differs from the other Cynodonts in the following characters:—

1. The nostril is directed more forwards than outwards.
2. The nasal is not widened posteriorly.
3. The prefrontal is larger than the lachrymal and prevents the lachrymal from meeting the nasal.
4. The frontal forms part of the orbital margin.
5. The postorbital arch is feeble: incomplete in *Bauria*.
6. The molars show no sign of cusps.

In the following characters *Sesamodon* comes nearer the Mammals than any of the other known Cynodonts:—

1. An articulation for the lower jaw which permits of some degree of antero-posterior movement.
2. The lower canine lies outside the edge of the maxilla when the jaw is closed.

In addition to the mammalian characteristics peculiar to *Sesamodon*, it combines most of those mammalian characters seen in *Bauria* with most of those found in the other higher Cynodonts.

Peculiarities of the Mammalian Skull, apparently derived from a Cynodont Ancestor.

Most of the bones of the mammalian skull have their homologues in the Labyrinthodont skull, but they are also to be found in the skulls of most reptiles. There is, however, no close resemblance between the mammalian and the batrachian bones, and in many cases the differences in cranial structure are so great that the gap between the mammal and any known batrachian must be enormous. When we examine the Cotylosaurian skull, we find that the resemblance to that of the mammal is still remote, but any little resemblance there was in the Labyrinthodont is here increased, while there are many mammal-like characters not seen in the lower type.

The Pelycosaurians of the Lower Permian are so much more mammal-like than any of the lower forms that, notwithstanding their remarkable specialisations, one cannot help feeling, as Cope felt, that here were forms fairly near to the remote mammalian ancestor.

The Therocephalians and Anomodonts of the Middle Permian times are in essentials still more mammal-like. For the first time we get a dentition clearly divided into incisors, canines, and molars; for the first time we get a lower jaw with a dentary which has a large coronoid process. We get a zygomatic arch formed on the mammalian type, and we lose for the first time the quadratojugal. We also get most marked mammalian characters in the postcranial skeleton.

The Therocephalians survived into Upper Permian times, but hitherto they have not been found in Triassic beds. In Upper Triassic times their place was taken by the Cynodonts. Though the gap between the Therocephalians at present known and the Cynodonts is very considerable, the primitive Cynodont *Bauria* is to some extent a connecting link.

Almost all the characters in which the Cynodont skull differs from the Therocephalian are characters which are met with in Mammals. Of these the most noteworthy are:—

1. Formation of a secondary palate.
2. Vomer very large, extending forward as a support to the secondary palate.
3. Great reduction or complete loss of prevomers (*Bauria*).
4. Loss of the postfrontal bone.
5. Great reduction or loss of the pineal foramen.
6. Two occipital condyles.
7. Reduction of the quadrate.
8. A large alisphenoid bone instead of the homologous rod-like "epipterygoid" or columella cranii of the Therocephalians and Anomodonts.
9. Pterygoids not extending back to the quadrates, the posterior extension being replaced by the alisphenoids.
10. Reduction of the angular and surangular, and greater development of the dentary.

The presence of this large number of mammalian characters in the Cynodont skull, and the absence of any in either skull or skeleton that might not have been expected in the mammalian ancestor, make the case very strong for the mammalian ancestor having been a Cynodont. But the evidence becomes even stronger when we find that most of the peculiarities, even minor peculiarities, of the mammalian skull have light thrown on them by the condition of affairs in the Cynodont skull.

Let us consider some of the more remarkable characters of the mammalian skull in the light of our knowledge of the Cynodont.

Premaxillary.

One of the most striking peculiarities of the mammalian skull is that the nostrils are separated only by cartilage, so that if the cartilage be removed the nostrils are united. In most reptiles, in birds and amphibians the nostrils are divided by an upward and backward process of the premaxilla, the internasal process. As it is present in Cotylosaurs, Dromasaurs, Pelycosaurs, Therocephalians, Anomodonts, and even Cynodonts, one might fancy that here was evidence against the Cynodont ancestry. But there is good reason to believe that the early Mammals retained the internasal process and that it was only lost after the Mammals were well established.

In both *Ornithorhynchus* and *Echidna* the young animal has an internasal process developed on the premaxilla almost exactly as in reptiles. The fact that it is retained as a support to the caruncle or egg-tooth in no way invalidates the conclusion that it is the reptilian internasal process that has been retained. For there cannot have been a time when there was a caruncle without a support, and thus the internasal process must be as old as the caruncle. As we may be pretty certain that the mammalian ancestor was oviparous, we may safely conclude that the internasal process is not a neomorph, but the reptilian structure handed on.

In *Tritylodon* there is an imperfect but distinct little internasal process. The only known specimen is too imperfect to enable me to say whether it formed a complete though slender process which joined with the nasals. Even if it did not in the adult, it is rather probable that it did in the very young animal, since *Tritylodon* is so much more primitive than the marsupial that not improbably it was oviparous.

In the skulls of young Diprotodonts (e. g. *Macropus*) a rudiment of the internasal process is usually present. And in the young *Trichosurus* at birth the internasal process, as I recently pointed out, can be traced right round in front of the nose. In the very young marsupial, the nostrils are entirely lateral and wide apart, and the nasal cartilages pass round in front of each, leaving a sulcus in the middle line between the two. The premaxillaries send up short processes along the sulcus, but from the ends of the processes two strands of condensed but unossified cells can be easily

traced round to the top of the snout. Were these tracts ossified we would have a condition practically similar to that of the Cynodont.

Septomaxillary.

Kitchen Parker many years ago recognised this as a distinct membrane-bone in the Lizards and Snakes, but it is only recently that much attention has been paid to it, chiefly as the result of the work of one or two palæontologists in Europe and America. The bone is not known in Labyrinthodonts and probably does not occur in the Amphibia (the supposed septomaxillary of *Xenopus* being probably not homologous). We find it, however, in the very earliest true reptiles, and we can trace it on the one hand through numerous members of the Diapsida, and on the other through most of the mammal-like Reptiles on to Mammals.

A septomaxillary has been found in *Pareiasaurus*, *Pariotichus*, and *Procolophon*. In these primitive genera it is mainly within the nostrils, and probably fulfils its main function as a roof to Jacobson's organ.

When we come to the mammal-like Reptiles, we find it in the Pelycosaurids still mainly within the nostril. In the Dinocephalians (*Delphinognathus*, *Tapinocephalus*) it comes partly on to the face. In the Dromasaurians (*Galepus*), it forms a very appreciable portion of the facial wall; and in the Therocephalians (*Scylacosaurus*, *Aloposaurus*), it also appears pretty largely on the face. In the Anomodonts it is absent, probably because they had lost their organ of Jacobson, as would appear from the loss of the prevomer.

In the Cynodonts, the septomaxillary is always present. In the lower types it appears on the face, but in the higher forms it is almost entirely inside the nostril.

Among Mammals a septomaxillary is known only in some of the lower forms. In *Tritylodon* it appears on the face between the nasal and premaxillary, in much the same way as in *Nyctosaurus*. In *Ornithorhynchus* and *Echidna* it would appear from the researches of Gaupp that what used to be regarded as the upper part of the premaxillary is really the septomaxillary. If this be so, as seems pretty certain, then the Monotremes have the septomaxillaries better developed than in the Cynodonts.

The only higher mammal in which there is a bone to be regarded as probably the septomaxillary is *Dasyurus*. Here a small bone, which I described in 1897 as the "nasal-floor bone" and suggested might be homologous with the upper part of the premaxillary in the Monotreme, is probably to be regarded as a rudimentary septomaxillary.

Vomer and Prevomers.

In 1895, and more fully in 1902, I showed that there was reason to believe that the so-called reptilian "vomeres" were not homologous with the mammalian vomer, but that being formed as splints to the paraseptal cartilages in close association with the

organs of Jacobson, they were really homologous with the bones that unite to form the "dumb-bell bone" of *Ornithorhynchus*; and that the mammalian vomer had its homologue in the so-called "parasphenoid" of the lower forms. As a new name was necessary for the reptilian "vomeres," I proposed the name *prevomer*.

In the Batrachia we find all three bones well developed, the median true vomer or parasphenoid being especially large to support the base of the skull. When in the earliest true Reptiles the pterygoids came together, there was little need for the median vomer and it became greatly reduced. In the Cotylosaurian *Diadectes* the median vomer is still a fairly strong rod, but in the later Cotylosaurians or primitive Diapsidans *Pariotichus* and *Procolophon* the vomer is a very short pointed process. In most later Diapsidans the vomer remains a small unimportant element. It develops to a fair size in the Ophidia and becomes large and much specialised in the Chelonia. The prevomers, on the other hand, remain large in most Diapsidans, but where, as in the Chelonians and Crocodilians, the organs of Jacobson become much reduced or lost the prevomers likewise tend to disappear.

In the mammal-like Reptiles the vomer shows great variations. In the Therocephalians it is small as in the primitive Diapsidans, but with the development of a secondary palate a new function is given to it, and it becomes large. In the Anomodonts, though the secondary palate is only imperfectly formed, the vomer is large and extends well forward. In the Cynodonts, where the secondary palate is complete, the vomer is very large and extends from the basisphenoid to near the front of the snout. The front part of the bone corresponds so exactly in its relations to the mammalian vomer, that it is impossible to doubt that the bones are homologous. On the other hand, if the anterior part of the bone were lost it is probable that every one would agree, from the relations of the back part, that it was the homologue of the reptilian so-called "parasphenoid." In Mammals the vomer varies greatly in size. It is relatively very large in the Cetacea, sometimes extending from the basioccipital to the front of the rostrum, while in the Rodentia it is often more or less rudimentary.

The prevomers are large in the Dinocephalians and Therocephalians. In the Anomodonts they have completely disappeared. In the Cynodonts, with the formation of the secondary palate they are either greatly reduced (*Gomphognathus*) or quite absent (*Bauria*). In Mammals the prevomers are usually absent, their function as supports to Jacobson's cartilages being taken by the palatine processes of the premaxillæ. In only two mammals are they known for certain to occur as distinct bones, viz. *Ornithorhynchus* and *Miniopterus*, and in both of these the pair of bones fuse together to form a median bone before the animal is full-grown.

Some observations have recently been made which at first sight appear to cast a little doubt on the homology of the parasphenoid with the mammalian vomer.

Versluys has discovered what he believes to be a large parasphenoid in *Dermochelys* in addition to the vomer and in no way connected with it. If this determination be correct, it will probably turn out that the Chelonian vomer is after all a pair of prevomers fused. The early development of the Chelonian vomer has not, so far as I am aware, ever been examined, and in my paper on the reptilian and mammalian vomerine bones I spoke very guardedly on the subject. So far as we know, the Chelonian vomer is always a median unpaired bone. But if it be a true vomer, what of Versluys' supposed parasphenoid? Fuchs has shown that in *Chelone* the basisphenoid is ossified by a large irregular exostosis on its under side, and that this exostosis bears relations to the pterygoids very similar to those which the parasphenoid of Versluys does. In the light of the observations of Fuchs, I think it must be concluded that the supposed parasphenoid in *Dermochelys* is entirely a development of the basisphenoid, and not the homologue of the parasphenoid of other reptiles.

Gaupp and Fuchs have both apparently discovered a rudimentary ossification behind the vomer in Chelonians which they believe to be a true parasphenoid, and Fuchs has discovered what he believes to be a rudimentary parasphenoid in *Didelphys*. The situation of these rudimentary ossifications is undoubtedly that of the parasphenoid, but they are also in the region normally occupied by the vomer in Mammals. When a bone which occupies one region in an ancestor comes to occupy a somewhat different region in a descendant through a portion of the bone becoming aborted, it is by no means uncommon that rudimentary ossifications can be detected in the region abandoned. The os carunculæ is undoubtedly the internasal process of the premaxilla in *Ornithorhynchus* and *Echidna*, but though it is quite detached from the premaxilla, it is nevertheless a portion of the premaxilla. In the case of the vomer, supernumerary ossifications appear to be not uncommon both in front and behind. In *Orycteropus* there are two small ossifications in front, apparently not prevomers, but detached ossifications of the true vomer. Kitchen Parker seems to have found them so commonly present that in some groups he regarded them as the rule. Speaking of the condition in Marsupials he says: "The main vomer is often relatively small; there is, nearly always, a pair of antero-lateral vomers . . . and large postero-lateral, and other, or postero-medial vomers; these are very irregular and unsymmetrical in the young *Cuscus* especially, in which I find *ten* vomerine bones." Parker's postero-medial vomers are probably the ossifications regarded by Fuchs as parasphenoids, and there seems no reason to regard them as of any more morphological significance than the Wormian bones in the human skull.

Alisphenoid.

Until recently the alisphenoid bone has been looked upon, like the orbito-sphenoid, as an ossification of the cranial wall, and

according to Parker "the alisphenoids and orbito-sphenoids appear as chondrifications of the walls of the skull." In studying the development of the marsupial skull some years ago, I found that the alisphenoid has originally nothing to do with the walls of the skull. It first appears as a short rounded rod lying outside the trabecula and quite independent of it or of any other skeletal structure. In its relations it seems exactly to correspond to the middle part of the cartilaginous bar on which the pterygoid bone develops in Lizards and *Sphenodon*. In the majority of Lizards this middle part gives rise to the epipterygoid or columella cranii. When, as in *Chamaeleon*, the epipterygoid is rudimentary, the short bar which forms its base is almost exactly similar in structure and relations to the bar from which the alisphenoid develops in Mammals. One therefore seems driven to the conclusion that the epipterygoid and the alisphenoid are different developments of the same element. And this conclusion seems borne out by comparative anatomy, for we find that most Reptiles have either an epipterygoid or an alisphenoid, but never both. In Lizards we find an epipterygoid, but never an alisphenoid: in Snakes an alisphenoid, but never an epipterygoid.

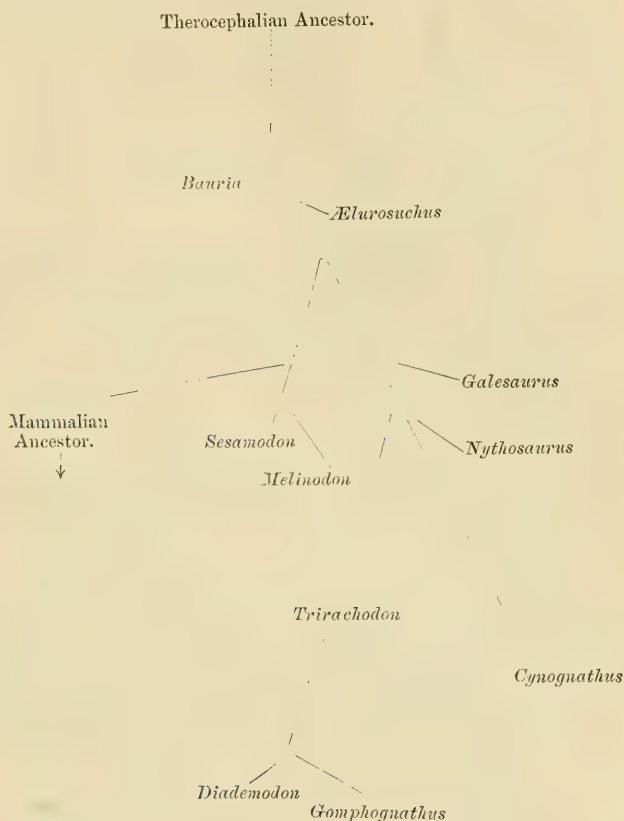
There seems little doubt that the epipterygoid is the early type of development. We find, for example, in the primitive *Procolophon* a columella cranii almost exactly like that of the lizard. In the Therocephalians the columellæ are long and slender, but usually flattened. In the Anomodonts they are slender, but rounded. In the Cynodonts we find no longer the columella cranii, but in its place a broad fan-shaped alisphenoid. The Cynodont alisphenoid further differs from the columella cranii of the earlier forms in having the lower part well developed and replacing the backward extension of the pterygoid. In the mammal the alisphenoid differs from that of the Cynodont mainly in having the 2nd and 3rd branches of nerve v. passing through it instead of behind it.

[*Note by* EDITOR.—In Dr. Broom's memoir as presented to the Society there followed here a discussion of the quadrate and tympanic, illustrated by two diagrams. A recent discovery made by Dr. Broom has considerably modified his views, and he has asked leave to withdraw the paragraphs omitted here until he has time to work out and present to the Society in a fuller form the bearings of his new facts.—August 11th, 1911.]

Angular.

The angular is found in all mammal-like reptiles. It is large in the Dinocephalians, Anomodonts, and Therocephalians, but comparatively small in the Cynodonts. In Mammals there is a small splint-bone on the lower side of Meckel's cartilage which is probably the remains of the angular. In *Ornithorhynchus* there appear to be two splint-bones, one being probably the surangular.

In the following diagram is represented what appears to be the genetic relationships of the principal known Cynodont genera :—



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Explanation of lettering in the Plate and Text-figures.

Ang. Angular; *Art.* Articular; *Aud.gr.* Auditory groove; *B.O.* Basisoccipital; *B.S.* Basisphenoid; *Dent.* Dentary; *E.O.* Exoccipital; *Ex.st.* Extrastapedial; *Fr.* Frontal; *Ju.* Jugal; *I.P.* Interparietal; *La.* Lachrymal; *Mall.* Malleus; *Men.* Meniscus; *Mx.* Maxilla; *Na.* Nasal; *O.O.* Opisthotic; *Pa.* Parietal; *Pal.* Palatine; *Pmx.* Premaxilla; *Po.O.* Postorbital; *Pr.F.* Prefrontal; *Pt.* Pterygoid; *P.Vo.* Prevomer; *Qu.* Quadrate; *S.Ang.* Surangular; *Sma.* Septomaxillary; *S.O.* Supraoccipital; *Sq.* Squamosal; *Tym.* Tympanic; *Vo.* Vomer.

EXPLANATION OF PLATE XLVI.

- Fig. 1. Side view of the cranial wall of *Cynognathus berryi*. Half nat. size.
2. Occiput of *Cynognathus berryi*. Half nat. size.
3. Side view of the skull of *Melinodon simus*. Nat. size. This represents the type and only known specimen. It is so badly crushed that it is impossible to restore it with any confidence. Six molars of the right side are preserved, and the axes of two molar series make with each other an angle of about 60°. The frontal region is certainly narrow, and as the teeth are very similar to those of *Sesamodon* it is probable that the skull is also somewhat similar, but probably the snout is shorter in *Melinodon* and the skull relatively broader.
4. The molar teeth of the left side of *Sesamodon browni* as preserved. $\times 1\frac{1}{2}$.
5. Base of the skull of *Sesamodon browni* as preserved. $\times 1\frac{1}{2}$.
6. Quadrate and part of the squamosal of *Bauria cynops*, as seen from the front. Nearly twice nat. size.
7. Base of skull of *Bauria cynops*, viewed partly from the side to show the deep keel of the basisphenoid.
8. Occiput and base of skull of *Bauria cynops*, viewed from behind and partly from below. Slightly restored. About two-thirds nat. size.
9. Median section of skull of *Diademodon*. All parts in unbroken line are from the specimen in the South African Museum. The prevomer and septomaxillary as restored are founded partly on the British Museum specimen of *Gomphognathus* and are partly hypothetical, the inner part of neither bone being known in any specimen. About half nat. size.

39. Tooth-germs in the Wallaby *Macropus billardieri*.
By A. HOPEWELL-SMITH, L.R.C.P., M.R.C.S., and
H. W. MARETT TIMS, M.A., M.D., F.L.S., F.Z.S.,
King's College, Cambridge.

[Received and Read May 23, 1911.]

(Plate XLVII.* and Text-figures 181-189.)

The dentition of the Marsupials offers, in some respects, points of greater interest than does that of other mammals. Though much has been already written upon this subject, there are still problems awaiting solution.

The complete history of the tooth-genesis has been worked out in few members of this class, due no doubt to the difficulty of obtaining a sufficiently complete series of embryos of any one species. Any contribution, therefore, however small, may become of importance as forming a link in completing the chain of evidence.

The material upon which these observations are based consisted of three embryos of *Macropus billardieri*, obtained from the Seven Sisters Islands by Mr. Brooke Nicholls of Melbourne, to whom we are greatly indebted for his kindness in sending them for examination. These embryos give the following measurements:—

	STAGE I.	STAGE II.	STAGE III.
	mm.	mm.	mm.
Tip of snout to occiput (circumferentially)	21	35	38
" " " (in straight line)	15	27	27
Tip of snout to root of tail (circumferentially)	64	104	110
Vertex of head " " (in straight line)	35	66	52
Tail length	15	31	27
Total length from tip of snout to tip of tail (circumferentially)	79	135	137

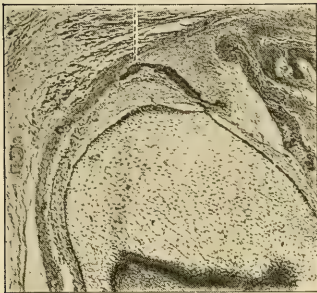
Serial sections were cut in a vertical transverse direction though the skulls of Stages I and II and stained with borax carmine. The jaws of Stage III, which gave measurements approximately equal to those of Stage II and presumably therefore of an embryo of about the same age, were dissected and clarified in oil of cloves after the method recommended by Huxley, to show the relative positions of the calcified teeth.

The most detailed accounts of the development of the teeth in Diprotodont Marsupials are those given by M. F. Woodward (12)

* For explanation of the Plate see p. 942.

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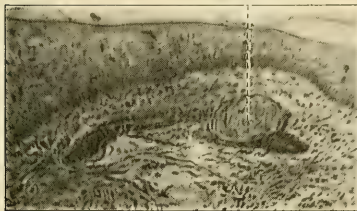
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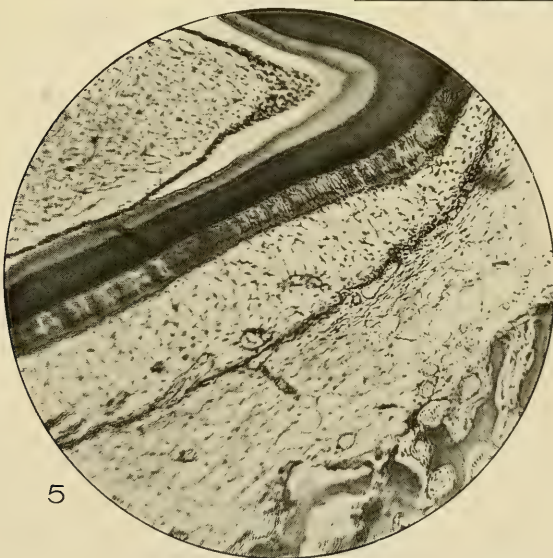
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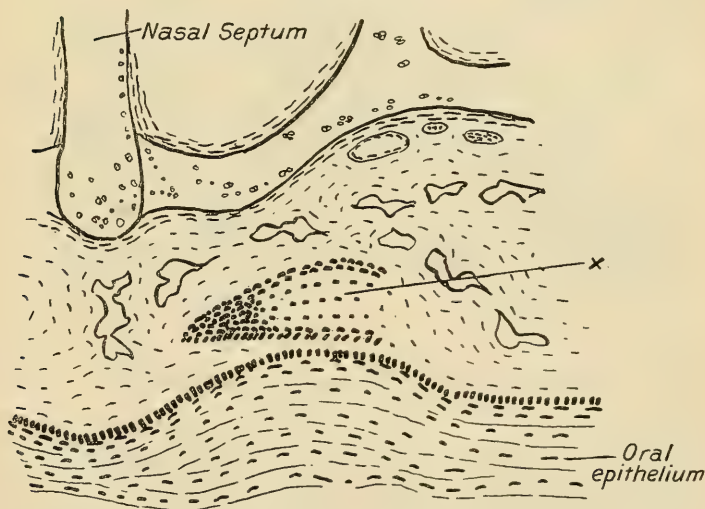
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and by Deppendorf (1); the latter, however, does not appear to have examined any specimen of *Macropus*. Woodward has furnished the results of his examination of 14 embryos belonging to four species, viz. *M. giganteus*, *M. eugenii*, *M. bennetti*, and *M. brachyurus*. From the measurements given by him, allowing for the differences in size of the adult animals of the different species, our Stage I would appear to be considerably younger than any of the embryos which he examined. Before discussing the general considerations arising from our observations, we will proceed to a description of the conditions found in our material.

STAGE I.

Upper Jaw.—At the anterior extremity of the upper jaw the oral epithelium sinks into the substance of the jaw, forming a broad triangular cellular mass the outline of which is very irregular. There are projections of some size extending laterally into the premaxillary region. None of these would, by themselves, suggest tooth vestiges, but the possibility of their being of such a nature is not entirely negatived because, as will be shown in the sequel, similar but more definite structures are to be seen in the lower jaw. The evidence here is, however, too problematical to permit of definite conclusions being drawn.

Text-fig. 181.



Section showing the tooth-band (X) passing horizontally inwards and forming the anterior part of the tooth-germ B.

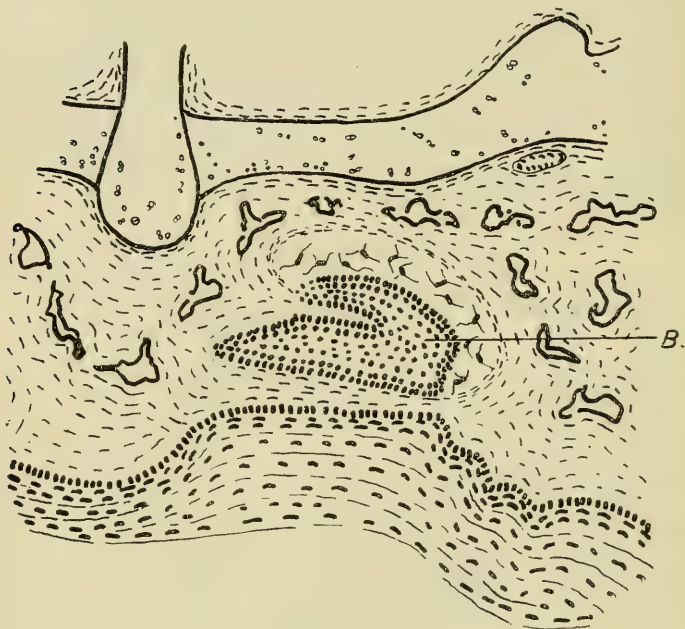
On either side of the middle line close to the nasal septum is a minute slightly calcified tooth-germ with a dental papilla of

definite shape. This germ will for the present be indicated by the letter *A*.

From a point just external to the point of connection of the neck of the enamel organ of *A* to the oral epithelium, the tooth-band passes horizontally inwards towards the middle line (text-fig. 181)*. This rapidly increases in size, forming on section a conical mass of cells which soon loses all connection with the oral epithelium. From the histological characters of the cells and from the fact that in the more posterior sections a portion of the stellate reticulum of the enamel organ is visible, this structure must be regarded as a second tooth-germ (*B*).

It is considerably larger than the preceding germ *A*, though there is not the same amount of differentiation into the more typical dental tissues.

Text-fig. 182.



Section through the tooth-germ *B* at its deeper end.

The independent connection of the enamel organ *B* with the oral epithelium shows that it is not to be regarded as the morphological successor to *A*.

To neither *A* nor *B* are there either palatal or labial down-

* Owing to the difficulty of accurate orientation, the anterior sections of a jaw cut in the vertical-transverse direction will be in a plane parallel with the outer surface of the jaw. This has been borne in mind in describing the relative positions of the various structures.

growths which could serve as an indication as to which dentition the germs should be referred.

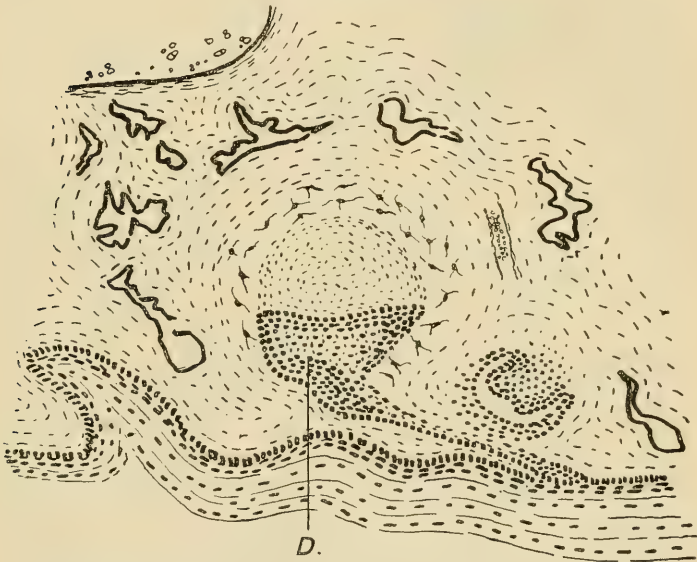
As this tooth is traced backwards it assumes a peculiar shape on section. Its inner margin is sharp, the outer one rounded, while on the dorsal surface is a relatively deep fissure (text-fig. 182).

The peculiarity of the adult tooth is thus early indicated.

As *B* disappears from the sections a new tooth-germ (*C*) makes its appearance. Though minute it has a fully formed enamel organ and dental papilla, but without any trace of calcification. This germ has a very superficial position in the jaw.

Closely following upon *C* is a large uncalcified tooth (*D*) lying to the palatal aspect of and slightly posterior to the preceding tooth-germ. Connected with the neck of the enamel organ is a minute predecessor slightly invaginated by a rudimentary dental papilla (text-fig. 183).

Text-fig. 183.



Section showing the tooth-germ *D* with its predecessor lying to the labial side of the neck-band.

Yet another germ (*F*) of some size soon makes its appearance, occupying a superficial position in the jaw. There is a slight bulging of the dental lamina to the labial side of the neck of this enamel organ, which may or may not indicate an abortive attempt at the formation of a predecessor.

The dental lamina from this point is continued backwards for some distance as a distinct band without showing any definite

trace of a tooth-germ. After an interval, another tooth (*H*) of considerable size appears, lasting through three slides. It has a dental papilla with blunted apex. As yet there is no definite evidence of calcification. There are neither palatal nor labial downgrowths of the dental lamina. This tooth we identify as the first of the cheek series.

The tooth-band continues backwards in a well-marked condition giving evidence of a distinct swelling which in Stage II has developed into an undoubted tooth-germ. Without a knowledge of the subsequent history of this swelling, one would have hesitated to attach importance to it.

Posteriorly to this is the large enamel organ of Stage I from the neck of which springs a definite palatal downgrowth of the dental lamina. The shape of the dental papilla is definitely molariform, the outer cusp already attaining to a higher level than the inner.

One more enamel organ (*J*), the most posterior in the jaw at this stage, is to be seen following closely upon the preceding one. It has but reached the flask-shaped stage.

Thus it is seen that there are representatives of eight teeth in the upper jaw at this stage which, by comparison with those present in Stage II, we identify as incisors 1, 2, 3, 4 and 6, and premolars 1, 3 and 4. The reasons which have led us to arrive at this conclusion will be detailed subsequently.

Lower Jaw.—Near to the mandibular symphysis is a well-defined involution of the oral epithelium into the subjacent mesoblastic tissues. The cells, both peripheral and central, of this tubular downgrowth have precisely the same characters as those covering the alveolar margin. From the appearance of these cells and from the inclination of the downgrowth (downwards and towards the middle line) being the same as that of undoubted tooth-germs situated more posteriorly in the jaw, the opinion that it is a vestigial tooth-germ (*a*) seems to be justified. Very closely following upon this structure and placed at a deeper level in the jaw, is a small well-calcified tooth (*b*) showing both dentine and enamel. The appearance of this tooth suggests degeneration, and it may safely be asserted that this tooth, though calcified, is not the one which will ultimately become the functional incisor.

The difficulty in identifying the exact relationships of tooth-germs close to the symphysis is always great, due in part to a certain amount of crowding, accentuated in the Macropodidæ by the very large size of the functional incisor and in part to the difficulty of correct orientation. We at first thought that these two structures stood to each other in the morphological relationship of predecessor and successor. From a careful consideration of all the facts we believe that this is not the case, but that they are the representatives of two separate teeth and that the close approximation to each other is due to the crowding caused by the large functional incisor. The appearance of *a* suggests a tooth

which is attempting but failing to develop; it has not the "concentric" appearance of a vestigial tooth-germ such as one so often sees as the last evidence of existence of a predecessor to a calcified tooth.

Rapidly succeeding the calcified tooth *b* is a well-defined flask-shaped dental rudiment lying in a very superficial position in the jaw. This, though close to, is quite independent of any of the other tooth-germs here present and will in the meanwhile be referred to by the letter *c* (text-fig. 184).

Text-fig. 184.

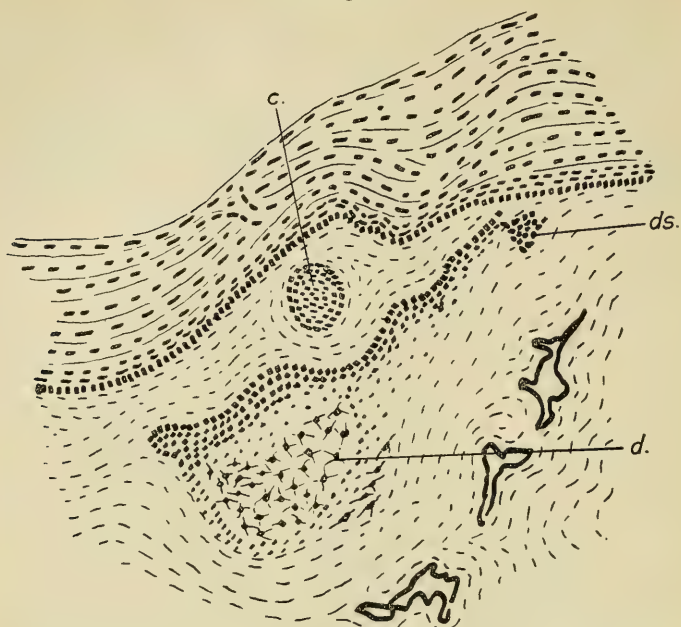


Section showing flask-shaped rudiment of tooth-germ *c*.

At this point the dental lamina runs horizontally inwards, as in the upper jaw. It forms a thickened band of cells lying some distance below the tooth-germ *c*. Tracing this band backwards it quickly becomes connected with the upper part of the enamel organ of a large tooth (*d*) in which the dental tissues are differentiated and which extends through several slides. In relation to the neck of this enamel organ is a lingually situated downgrowth of the dental lamina indicating a potential successor (*ds*) to the tooth *d*. From this point the tooth-band vanishes for some distance (text-fig. 185).

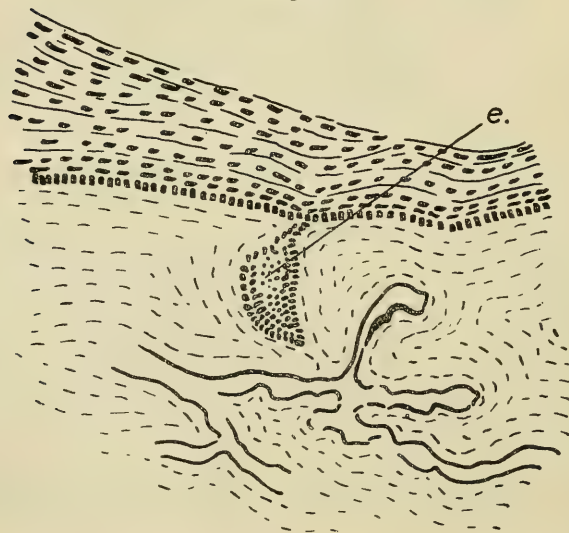
As the tooth itself dies out the dental lamina once more comes into prominence and gives rise to an enlargement indicating in our

Text-fig. 185.



Section through posterior end of tooth-germ *c* and commencement of enamel organ of *d* and rudiment of a successor to *d*.

Text-fig. 186.



Section showing the enlarged downgrowth of the dental lamina indicating the vestige of the tooth-germ *e*.

opinion a tooth vestige (*e*). It lies close beneath the alveolar margin (text-fig. 186).

Then occurs a further interval through which the tooth-band persists without giving rise to any further dental enlargements. Three further teeth (*h*, *i*, and *j*) of premolariform pattern, follow in the cheek region. Of these the middle one is considerably the most extensive, the posterior one being quite small. To the two anterior teeth there are indefinite indications of lingual downgrowths of the dental lamina.

As in the upper jaw there are indications of eight teeth, five antemolars and three maxillary teeth.

A general impression of the number and relative positions of the dental structures in both jaws may perhaps be best realised by the following diagram, which has been drawn to scale in the horizontal direction.

Text-fig. 187.

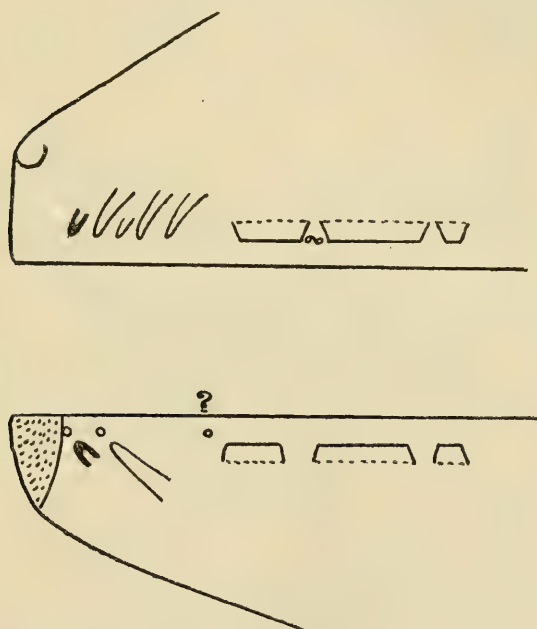


Diagram showing number and relative positions of the tooth-germs in the jaws of Stage I. Calcified germs more heavily outlined.

STAGE II.

The difference in size between this embryo and that of Stage I is very considerable, and as a consequence a number of additional teeth have appeared in both jaws and those which were present in the earlier stage have developed very materially. It is unfortunate that we have not had at our disposal an embryo of

intermediate size, as this would have rendered the precise interpretation a matter of less difficulty and of greater certainty.

Without going into details we will summarise as briefly as possible the conditions found in the later stage.

Upper Jaw.—Anteriorly is a small calcified tooth (A') occupying a position similar to the tooth found in the previous stage and is undoubtedly the same tooth still persisting. It shows no signs of being erupted, neither has it undergone any further development. That it will ultimately become absorbed without attaining functional activity seems to be certain.

Behind this lies a large incisiform tooth already heavily calcified. This tooth (B') is the largest of the anterior series. All traces of the tooth-band between A' and B' have become lost, and several sections intervene between the disappearance of A' and the commencement of the enamel organ of B' . Thus we are of the decided opinion that these are two morphologically distinct teeth, a point to which reference will be made later. This conclusion is the same as that at which we arrived in Stage I.

C' is still a small uncalcified tooth lying superficially, and appears to have been pushed out of the serial line towards the outer aspect of the jaw.

D' is very similar to B' , but perhaps not quite so large. Posteriorly to D' is a small calcified tooth (E') of irregular shape and situated close to the alveolar margin of the jaw. This tooth is obviously vestigial and will never become functionally active. According to our identification this tooth is unrepresented in the earlier stage.

After an interval another large incisiform tooth is seen (F'). It is neither so large nor so heavily calcified as B' or D' .

G' is a tooth of some size showing but traces of commencing calcification. From its relation to the premaxillo-maxillary suture we regard this tooth as the canine. It is a tooth in an early stage of development which has appeared since the age of Stage I. There is a "concentric epithelial body" which is to be regarded as the last trace of a vestigial predecessor.

The first of the true maxillary teeth is elongated and of premolariform type (H') without any indications of a predecessor or successor. The third tooth (J') is like unto it but of much larger size, extending through many more sections.

Between these two calcified teeth is a *very deeply placed* tooth-germ with a neck of remarkable length (I') (Pl. XLVII. fig. 1). There is no evidence of calcification. This is evidently the second maxillary tooth which, crowded between the large calcified first and third, has been forced into the abnormally deep situation, besides being pushed from the linear series towards the palatal side of the jaw.

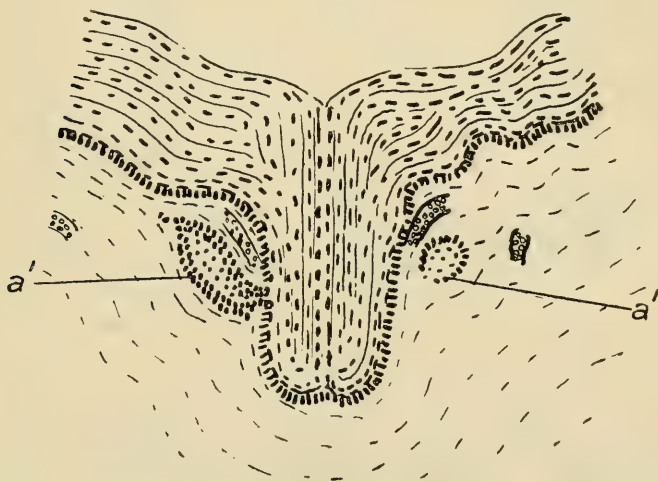
The fourth maxillary tooth (K') is large and in it calcification is but just commencing. From the neck of the enamel organ springs a marked labial downgrowth of the dental lamina, connected with which is a "concentric epithelial body," the vestige

of a predecessor (Pl. XLVII. figs. 2 & 3). The importance of this will be discussed later. The last tooth of the series (*L'*) is uncalcified and at an earlier stage of development than the maxillary teeth in front of it. It lies much nearer to the alveolar margin than do the others, and there is this further point of interest, that the anterior end of this tooth overlaps superficially the posterior end of the tooth in front, which is distinctly not the case with the more anteriorly situated teeth.

According to our identification we recognise at this stage six incisors, one canine and five maxillary teeth.

Lower Jaw.—The difficulty of interpreting the appearances in the region of the mandibular symphysis is even greater than in the earlier stage. The enormous development of the lower functional incisor, extending as it does through thirty slides*, has disarranged all the parts, more particularly anteriorly where the tip of the tooth becomes more superficial and where it now reaches well in front of the point at which its young enamel organ connected with the oral epithelium.

Text-fig. 188.



Section showing involution of the oral epithelium
at the mandibular symphysis.

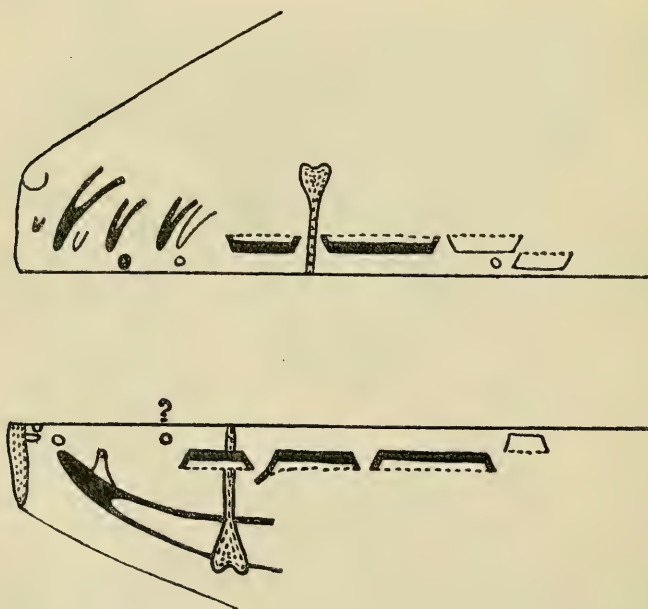
At the symphysis the oral epithelium is turned inwards in the middle line so as to partially cover the opposing ends of the mandibular rami. At this point there is a definite involution of the epithelium into the subjacent tissues. The section being cut at this point in a plane parallel with the anterior surface, the

* A rough estimate may be obtained by stating that a slide carries an average of twelve sections, each section being $\frac{1}{100}$ mm. in thickness.

direction of this digitiform involution is inwards and slightly upwards. There is an involution on either side of the symphysis and they are quite symmetrical. The position makes the interpretation somewhat doubtful, otherwise we should have but little doubt in ranking them as tooth rudiments. Regarding the origin, connection, and histological characters as of more importance than mere position, we shall regard it as such and provisionally indicate it by the letter *a'* (text-fig. 188).

Close to the middle line, but on the alveolar margin of the mandible, is a more globular involution containing cells commencing to be arranged as a concentric epithelial body such as several authors now recognise as being tooth vestiges. This will be referred to as *b'*. This also is a bilaterally symmetrical structure and extends through several sections. Immediately above this is a fissure in the oral epithelium containing some deeply stained fibrous-looking material. The appearance suggests the possibility of this marking the situation where the minute calcified tooth, present in the jaw in this position in the earlier stage, may have been erupted. There is otherwise no trace of the calcified vestige.

Text-fig. 189.



Showing the relative positions of the teeth in Stage II.
Calcified teeth more heavily outlined.

A broad bulbous involution of the oral epithelium is seen close to the middle line (*c'*) which soon loses its connection with the

alveolar epithelium, remaining as an isolated spherical mass. It probably is the same structure described in Stage I, and is naturally of larger size.

Lying at a deeper level but entirely independent of it, is the anterior extremity of the large calcified functional incisor. That these two structures have no morphological relationship with each other is made clear, not only by their relative position but also by the fact that the connection of the enamel organ with the surface is definitely visible in a section farther back, together with a "concentric" vestige of a predecessor and an indication of a potential successor. This large functional incisor we shall indicate as *d'*.

Then follows an interval of thirteen slides without any trace of teeth, and throughout the greater part of this interval the dental lamina is scarcely visible. At length a definite "concentric epithelial mass" occurs embedded in the dental lamina. It is impossible to say whether this is the vestige of a canine or of an outer incisor. From its position relative to that of the opposing teeth, it is probably the vestige of the latter tooth. The point in favour of its being a vestigial canine is its propinquity to the first true post-canine tooth. However, it is a point of quite minor importance.

The description already given of the true maxillary teeth applies almost equally well to the corresponding structures in the lower jaw. The only two points to which attention may be drawn are (i) the larger size and definite calcification of the 4th tooth of the lower series; and (ii) the absence of a definite "concentric" predecessor to the same tooth, though there is a very minute structure which may indicate its remains, the position in relation to the tooth itself being the correct one. That it should have disappeared is what would be expected from the greater size and calcification of the successional tooth.

III. HISTOLOGY.

There are certain histological peculiarities revealed by an examination of these jaws. They are briefly as follows:—

(i) The oral epithelium along the alveolar margins is very thick and heaped up to an unusual extent. In no other mammal that we have examined have we ever seen this character carried to such excess. This is the "Zahnwall" of the German writers. It is said to be a marked character in the Ungulates, and in our experience it is certainly not of common occurrence among mammalia generally. Of course no morphological significance is implied by the comparison.

(ii) The somewhat unusual compactness of the stellate reticulum and the definiteness of the stratum intermedium of the enamel organ.

(iii) The precocious development of the enamel which seems to calcify as soon as the dentine, and even in some cases to

precede it. Spherules of calco-globulin are clearly seen in many of the ameloblasts.

(iv) The abundant evidence of blood-vessels within the enamel organ is a very striking feature (Pl. XLVII. fig. 5). The fact of the vascularity of the enamel organ is one upon which there are contradictory statements. Wedl, Magitot, Legros, Sudduth and Paul deny the existence of blood-vessels in this situation. On the other hand, Prof. Poulton and the late Prof. G. B. Howes have mentioned their presence in the enamel organs of the Rat.

In *Macropus* there is no doubt whatever. They can be seen entering the enamel organ apparently at more than one point on the surface, and are often of sufficient size to clearly recognise the blood corpuscles within them. They can be traced to a point about midway between the outer and inner enamel epithelium, but we have not seen them proceeding farther, neither have we found them in the stratum intermedium, the position in which they were described by the authors above mentioned.

The fact of the vascularity of the enamel organ is one of importance in connection with the various theories held as to the processes of the calcification and enamel formation and of the functions of the stellate reticulum. It is extremely probable that the unusual vascularity of the enamel organs in this animal is correlated with the precocious development of the enamel, to which reference has just been made.

(v) Evidence of the fusion of enamel organs. There appears to be some evidence of the possibility of the occurrence of such fusion though the evidence is not decisive. Pl. XLVII. fig. 4, shows the subdivision of an enamel organ into two parts by an epithelial septum passing from the outer enamel epithelium to the inner where the latter lies over the apex of the dentinal papilla. This occurs in more than one cheek-tooth and may be seen on both sides. We have never met with anything of the kind before. That this septum is not a small capillary running directly across the stellate reticulum we are assured. We can offer no other suggestion than that it is a double enamel organ taking part in the formation of a single tooth.

This is a point of considerable morphological importance as bearing upon the question of the evolution of the molar patterns. Fusion is presupposed to have occurred by all writers who believe in any form of concrescence, but little satisfactory evidence has been forthcoming in the mammalia and little weight can be given to the evidence derived from the disintegration of the Cetacean molars.

Amongst the lower vertebrates the evidences of fusion seem to be conclusive. In one family of upper Palæozoic Sharks, the *Cochliodontidae*, there is a fusion into plates not only of adjoining teeth of one series, but also of successional teeth of several series. Semon (4) has also shown that a fusion of individual cusps takes place in *Ceratodus*, and Röse has seen the cusps in the process of fusion in the teeth of a chameleon (3). Woodward (*loc. cit.*) speaks

of a supernumerary incisor in the upper jaw of an adult *Perameles* in the teaching collection of the Royal College of Science in which there are "indications of at least three fangs, and is obviously a fusion of (these) teeth." The possibility of tooth fusion in the mammalia is therefore by no means improbable. The matter must remain unsettled until more satisfactory evidence is forthcoming, but the condition figured would seem to point in that direction and we can only repeat that we can suggest no other explanation.

IV. GENERAL CONSIDERATIONS.

A. Serial homologies of the Teeth.

Upper Incisors.—Assuming our identification of the teeth to be correct, we have *six* incisors present in the upper jaw, of which the 5th is unrepresented in the earlier stage and has attained but a slight degree of development in Stage II. This excessive number of upper incisors confirms the original statement of M. F. Woodward (11), as the result of his observations on *Petrogale penicillata* and *Macropus giganteus*. That author is obviously aware of the difficulty in accepting so large a number, for he writes (p. 465): "The discovery of six pairs of incisors, although an absolute fact, is in many respects an unfortunate one, as we know of no adult mammal with so many, and even amongst Reptiles, many Lizards and Crocodiles have the number of teeth in each premaxilla restricted to five." He then proceeds to discuss various possible explanations such as the late calcification of the functional incisors in *Macropus* and the greater space in the premaxillary region in *Petrogale* as the possible determining causes. A reference to our text-figures 187 & 189 (pp. 933 & 936) will show that Woodward has possibly found the correct explanation, both factors appearing to be present in our specimens.

The difficulty is, however, not fully stated by a mere reference to recent forms, for Osborn (2) in his paper, "On the Structure and Classification of Mesozoic Mammalia," considers that the dental formula of the primitive heterodont mammal should be taken as i. 4, c. 1, pm. 4, m. 8.

In a paper published three years later (13) Woodward appears to have modified his former opinion, for in spite of having previously spoken of the presence of six upper incisors as "an absolute fact," he writes "I am now disposed to regard the three minute teeth which I described in the upper jaw of several genera belonging to this family" (*i.e.* Macropodidae) "as the premilk predecessors of the three functional incisors." He gives no reasons for the alteration in his opinion, as in his previous paper he discusses and discards the interpretation which he appears later to have adopted. He further makes no reference to the alteration in the identification of the homologies of the functional incisors which such a change of opinion would involve.

We have naturally therefore paid particular attention to these

views, and we agree with Woodward's first statement that the presence of six upper incisors, in spite of all the difficulties which it involves, is "an absolute fact." The one point upon which we join issue with Woodward is his view of the homology of the first functional incisor which he regards as being i. 1, whilst we hold that it is i. 2. The small calcified vestige in both our stages is clearly anterior to and independent of the first large tooth which is obviously the first functional incisor. Our disagreement is due to differences of interpretation of the conditions present in a very puzzling region, *i. e.* close to the median symphysis; and though we hesitate to put ourselves in opposition to so accurate and experienced an observer, we nevertheless are compelled to adhere to the opinions already stated. We are, however, quite in accord with him in regarding the outer functional incisors as being the 4th and 6th, the 3rd and 5th disappearing.

We, like Woodward, are therefore at variance with the opinion of Oldfield Thomas (5), who regards the missing incisors as being the outermost ones of the series. Though Deppendorf (1) does not appear to have examined the jaw of *Macropus*, he has made interesting observations on the tooth-genesis in many other marsupials. In *Aepyrymnus* he identifies the three functional incisors as the 2nd, 3rd, and 5th. Thus he agrees with us in the identification of the 1st functional teeth, but differs from both Woodward and ourselves in the identification of the two outermost functional premaxillary teeth. It is unfortunate that there should thus be four different versions given on this subject. Possibly the conditions described by Deppendorf may be really different and not merely a difference in interpretation, as he carried out his researches in other genera, in which the relative proportions of the bone may be somewhat different and thus produce different results.

Lower Incisors.—In the lower jaw we believe there are evidences of five ante-molar teeth. Whether the most posterior one is the vestige of a canine or of an outer incisor, it is impossible to determine. Of the remaining four the first three are vestigial, so that according to our interpretation the functional incisor of the adult is i. 4. This statement is at variance with Woodward's conclusion as to the homology of this tooth which he regards as i. 2. In his illustration he figures two vestiges which obviously correspond with our *b'* and *c'*, his first incisor in *Petrogale* being a minute calcified tooth just as is the germ *b'*. The morphological 3rd incisor of *Petrogale* is "more vestigial than the first," just as *c'* is more vestigial than *b'*.

The discrepancies between our interpretations probably depend on the following facts. (1) Woodward seems to have examined the jaw on one side only, and to do so would have divided it through at the symphysis. In doing so he would most certainly destroy the minute vestige *a'* which we have found lying practically within the symphysis. (2) He regards the posterior vestige as being posterior to the large functional incisor, whereas we regard it as being anterior. We both agree in stating that it lies close to the

tip of the large tooth, and there is no doubt that the exact morphological localisation of the vestige in relation to the large incisor is a matter of difficulty. On the whole, therefore, we are in closer agreement with Woodward's conclusions than with those of any other writer.

The close approximation which we have found between the representatives of these four anterior incisors is of considerable interest when we remember the condition of the lower incisors in *Didelphys*.

Canines.—These teeth call for no further observations.

Maxillary teeth.—The fourth true maxillary tooth of the upper jaw, as has already been stated, has a well-marked "concentric epithelial body" lying superficially to it. The importance of these structures as representing the last trace of a tooth vestige has been frequently insisted upon by one of us (H. W. M. T.) (7, 8), and the more recent researches of Wilson & Hill (10) seem to have placed the matter beyond doubt. So long as the present distinction as to whether or not there are predecessors is the criterion of distinction between premolars and molars, confusion is bound to result. Embryology often reveals the presence of these vestiges which breaks down this conception of a true molar tooth. It would in our opinion be better to call all post-canine teeth *maxillary teeth*. Until such a suggestion is adopted we must regard the fourth tooth of the series as a premolar (pm.⁴). The relationship of this tooth to the one immediately behind it suggests that the fifth tooth, *i. e.* m.¹, is the deciduous tooth which is replaced by pm.¹, a suggestion strongly urged by one of us in a previous paper (8).

It seems to be tolerably certain that the 2nd maxillary tooth will not be able to develop further, thus confirming the opinion of Oldfield Thomas that pm.² is the missing premolar.

The same interpretation holds good for the lower teeth.

To which dentition do the teeth of Marsupials belong?

No very decided answer to this question can be obtained from the material examined. Traces of a successional dentition are scanty, while those of a deciduous series are somewhat more abundant and more distinct. One of us (H. W. M. T.) has in more than one paper (6, 7) previously urged, upon general grounds, the view that the permanent dentition of the marsupials is the permanent dentition of the Eutheria and that both the deciduous and successional pm.¹ belong to one and the same dentition. This conclusion has been independently arrived at by Wilson & Hill (10) and adopted by C. S. Tomes (9). The joint authors of the present paper are in agreement upon this subject, and we have found nothing in the material which we have examined to cause us to doubt the correctness of this view.

NOTE.—I would desire to express my gratitude to the Odontological Society of Great Britain, for a grant in aid of researches

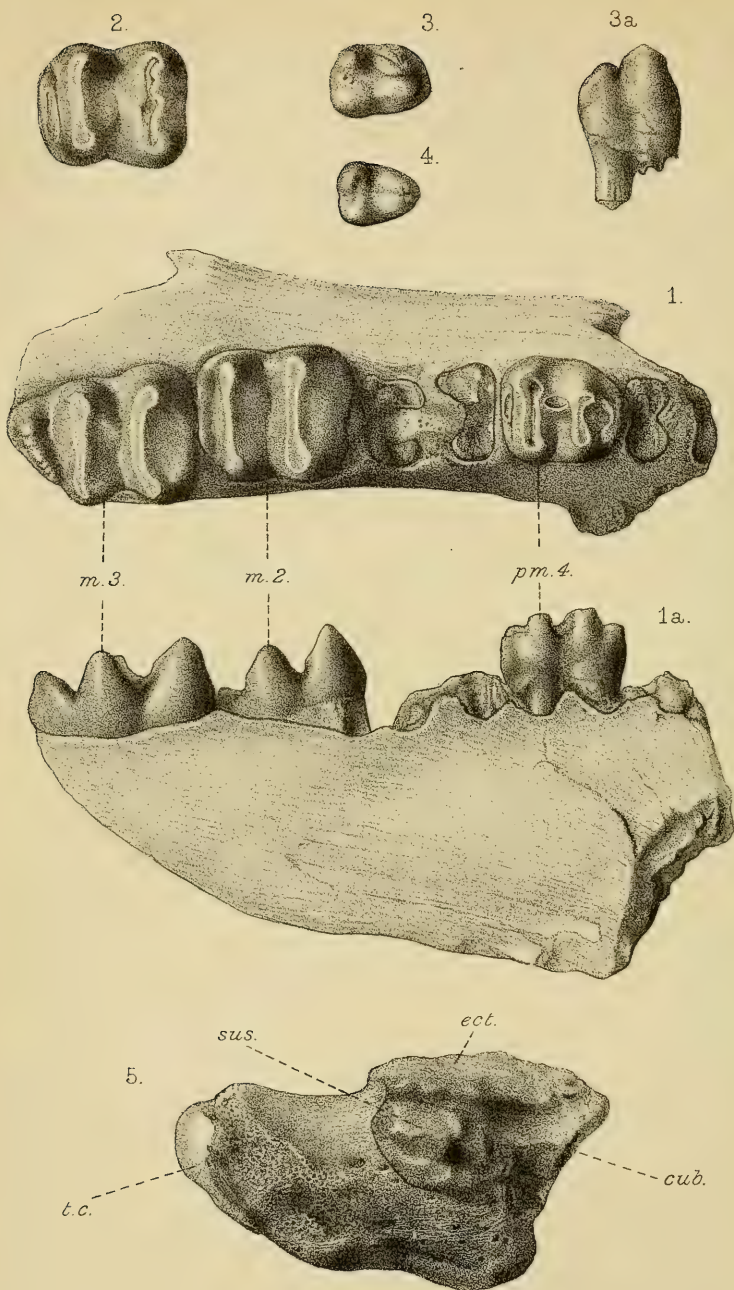
upon mammalian dentitions, and which has in part been used for the purposes of this investigation.—H. W. M. T.

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EXPLANATION OF PLATE XLVII.

- Fig. 1. Showing the deeply situated bulbous rudiment of pm^2 with the very long neck of the enamel organ reaching to the surface of the oral epithelium.
- Fig. 2. The enamel organ of pm^1 with the labial downgrowth of the dental lamina near to the free extremity of which is an enlargement, a “concentric epithelial body” (c.e.b.).
- Fig. 3. A “concentric epithelial body” more highly magnified.
- Fig. 4. Showing the sub-division of the enamel organ into two parts—? a fusion of two distinct enamel organs.
- Fig. 5. Showing the presence of blood-vessels within the stellate reticulum of an enamel organ.



40. On a New Species of *Dinotherium* (*Dinotherium hobleyi**)
from British East Africa. By C. W. ANDREWS, D.Sc.,
F.R.S., F.Z.S. (British Museum, Natural History) †.

[Received & Read May 23, 1911.]

(Plate XLVIII.‡)

During the last few years great additions have been made to our knowledge of the extinct mammalia of Africa, but hitherto the discoveries of their remains have been confined to the northern and southern portions of the continent. Now, however, a new find of mammalian bones in British East Africa shows that great hopes may be entertained that before long light will be thrown on the history of the group in the central portions of the continent. Recently Mr. C. W. Hobley, C.M.G., Commissioner of Mines in British East Africa, sent to the British Museum a small box of bones from the neighbourhood of Karungu on the east side of Lake Victoria Nyanza. Most of the specimens are indeterminable fragments, probably picked up on the surface, but in addition to these there are some beautifully preserved teeth with a portion of the mandible (Pl. XLVIII. figs. 1, 1 a) of a small species of *Dinotherium*; a small imperfect Proboscidean calcaneum (fig. 5), a patella, and some other fragments probably belong to the same animal. The teeth and bone are in a wonderfully good state of preservation, being hard and not easily broken, and there can be no doubt that further collecting in the same locality will yield results of the very highest importance and interest.

The teeth preserved all belong to the lower jaw: they are *pm.* 4, *m.* 2, and *m.* 3 of the left side, and *pm.* 3 of the right; the left *pm.* 4 and *m.* 2 have been replaced in their sockets in the portion of the jaw preserved; this also contains the freshly broken roots of *pm.* 3 and *m.* 1; *m.* 3 is isolated, the portion of the jaw behind *m.* 2 being lost. Anteriorly the jaw fragment ceases at the level of the front of *pm.* 2, where its inner border is turning in towards the symphysis; its ventral portion is missing, the dental canal being exposed.

The teeth.—The anterior premolar (figs. 3, 4) has a crown consisting of a high, laterally compressed antero-external cusp, to the inner face of which a shorter and more rounded antero-internal cusp is closely united. The hinder half of the tooth consists of a comparatively low and compressed outer tubercle separated from the antero-external cusp by a notch, and a small rounded inner

* [The complete account of this new species appears here, but as the name and a preliminary diagnosis were published in the 'Abstract' the species is distinguished by the name being underlined.—EDITOR.]

† Published by permission of the Trustees of the British Museum.

‡ For explanation of the Plate see p. 945.

tubercle which is joined to the outer by a ridge widening from within outwards.

The last premolar (*pm.* 4) (figs. 1, 1 *a*) consists essentially of two transverse crests which are united towards the outer side by a low obscure ridge. On the anterior face of the tooth there is a slight prominence of the cingulum, the surface of wear of which becomes continuous with that of the outer end of the anterior crest. There is also a low transverse ridge formed by the cingulum on the posterior face of the tooth.

The first molar has unfortunately been lost; the second (*m.* 2) consists of a pair of transverse crests, the ends of which, especially the inner end, are higher than the middle and the anterior face of which is concave. On the posterior end there is a well-developed ridge of the cingulum extending nearly the whole width of the tooth. The third molar (*m.* 3) is similar to the second except that it has a well-developed triangular talon, the outer side of which is formed by a prominent tubercle from which a crest diminishing in height and width runs to the inner edge of the tooth.

In size and, on the whole, in the pattern of the teeth this *Dinotherium* is very similar to *D. cuvieri* Kaup, which is from the lower and middle Miocene of France, being apparently especially characteristic of the Burdigalien horizon. Detailed comparison however shows some differences. In *pm.* 3 the separation of the antero-internal cusp is much more distinct than in a specimen of the same tooth ascribed to *D. cuvieri*; the last premolar is shorter in proportion to its width than in that species, and in the talon of *m.* 3 the outer tubercle is much more distinctly and independently developed. These differences, coupled with the remoteness of the localities in which the two forms are found, seem to justify the establishment of a new species for this East African animal and I propose that it shall be called

DINOTHERIUM HOBLEYI Andrews.

Abstract, P. Z. S. 1911, p. 35 (May 30th).

The dimensions (in centimetres) of the teeth in the type-specimen are:—

	Length.	Width.
<i>pm.</i> 3.....	4·0	3·2
<i>pm.</i> 4.....	4·9	4·2
<i>m.</i> 2.....	6·2	5·2
<i>m.</i> 3.....	7·2	5·4

An imperfect proboscidean calcaneum (fig. 5) probably belongs to this species. It belongs to the left side, and a great part of its outer half is broken away and some of the other faces are abraded. Its extreme length is 17·2 cm., the cast of a calcaneum referred to *Dinotherium giganteum* is 32·7 cm. or nearly twice as long.

From the same locality there have been obtained a lower molar

and the distal end of a radius of a small species of *Rhinoceros* (? *Aceratherium*), portions of the carapace of a very large Chelonian, probably a species of *Testudo*, fragments of the shell of *Trionyx*, and some Crocodilian remains.

From some portions of matrix adherent to some of the bones it appears that they are preserved in a bed of tough clay with much calcareous matter and numerous grains of blown sand; this deposit is probably of lacustrine origin, but in the absence of any molluscs or other invertebrates, it is not possible to be certain either as to its origin or as to its exact age. Judging from the *Dinotherium* remains, the beds are probably lower or middle Miocene. If they should fortunately turn out to contain a rich mammalian fauna, probably this discovery will lead to a great advance in our knowledge of the history of several groups of Artiodactyls, of the Hyracoids, and possibly of the Anthropeidea. It is greatly to be desired that a careful collection should be made as soon as possible.

EXPLANATION OF PLATE XLVIII.

Fig. 1. *Dinotherium hobleyi*, portion of left ramus of mandible with *pm.* 4, *m.* 2, *m.* 3, from above; 1 *a.*, ditto, from side. Type specimen.

2. Ditto, crown of *m.* 2 of another individual.

3. Ditto, *pm.* 3 of the type specimen from above; 3 *a.*, ditto, from side.

4. Ditto, crown of *pm.* 3 of another individual.

5. Ditto, left calcaneum from inner side.

cub., facet for cuboid; *ect.*, ectal facet; *sus.*, sustentacular facet; *t.c.*, tuber calcis.

All the figures are $\frac{1}{3}$ natural size.

EXHIBITIONS AND NOTICES.

June 13, 1911.

EDWIN T. NEWTON, Esq., F.R.S., in the Chair.

MR. H. G. PLIMMER, F.R.S., F.Z.S., Pathologist to the Society, presented a Report on the Pathological Examination of Rats (*Mus decumanus*) caught in the Regent's Park and in the Society's Gardens. 500 rats had been examined between the 1st of January and the 17th of May, 1911, all in a precisely similar manner. The spleen, lungs, glands, and blood were examined microscopically; and from any animal which looked in any way unhealthy cultures were made.

The results were summarized as follows:—5 rats were caught in the Park, and 495 in the Gardens: 283 of these were males and 217 females.

3 rats had tubercle, 10 had tapeworm cysts in the liver, 49 had *Trypanosoma lewisi* in their blood, 2 had empyema (not tubercular), 1 had a tumour of the lower jaw (the result of an old injury), and 1 had pleuritis and hydrothorax (not tubercular).

Bacteria were found in 71 rats: in 40 in the lungs, and in 31 in the spleen.

Saccharomycetes were found in the lungs of 16 rats.

Fleas were found on 4 rats, and lice on 3 rats.

The general condition of the rats was very good, and in none was anything at all suspicious found.

Dr. R. W. SHUFELDT, C.M.Z.S., sent for exhibition a photograph he had taken of a living specimen of a male albino Woodchuck, *Arctomys monax*, that had been sent to him from Virginia, U.S.A.

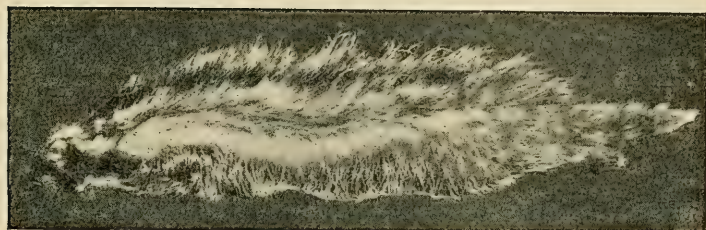
Mr. R. E. HOLDING exhibited and made remarks upon the Horns of a Highland Ram, a Fallow Deer, and a Roebuck, which were fused at the base, and also the skull of a coursing Greyhound with abnormal dentition.

Mr. R. I. POCKOCK, F.R.S., F.Z.S., Superintendent of the Society's Gardens, exhibited the skin and skull of a specimen of the rare Crested Rat, *Lophiomys ibeatus* Thos., which had been sent from Nakuru for the Zoological Gardens by Mr. R. B. Woosnam, C.M.Z.S., but had unfortunately died on the voyage. After alluding to the well-known peculiarities of the skull in this Rodent, Mr. Pocock drew attention to the arrangement and coloration of the hair (text-fig. 190), and expressed the opinion that the alternating areas of black and white with which each individual hair is ornamented, must make the animal conspicuous at dusk, if confidence be placed in the analogy supplied by such animals as Porcupines and Zorillas. The coat consists of two kinds of hair,—a softer close-set under-fur dusky grey at the base, then white, then dark at the tip, and much longer, coarser hair usually dark at the base, then white, then black, then white at the tip. These hairs are so arranged that the dark and white bands of the under-fur coincide exactly with the alternating bands of the same colour in the coarser hairs, while the long white tips of the latter project clear of the rest of the coat. From this arrangement it results that when the hair is raised the median white bands combine to form a continuous white mass thrown into relief by the dusky base and the distal black area, the whole being surmounted by the white tips of the long hairs shining with almost silvery lustre.

The coat of the upper side, moreover, is divided into three definite regions—a median dorsal and a lateral on each side—by a band extending from the shoulder to the hip and consisting of subspiniiform greyish hairs of peculiar spongy texture, and thick in the middle but narrowest at the base and apex. When the animal is viewed from above with its coat erect, the white areas of the region on each side below this dividing band form a

continuous white lateral stripe which anteriorly merges more or less, according to the species, with the white area on the summit of the head; and when seen from the side the same white stripe is visible as well as the white area of the hairs of the dorsal crest.

Text-fig. 190. .



Dorsal and side views of *Lophiomys ibeanus*.

In the typical form of *Lophiomys*, namely *L. imhausi*, the tail is longer and much whiter and the frontal band much longer and more conspicuous than in *L. ibeanus*. These two features

conjoined must, theoretically, combine to make the former species, or race, more easily seen at night than the latter.

That the Crested Rat is nocturnal was proved by observations made upon the specimen of *L. imhausi* that was kept in the Jardin d'Acclimatation, Paris. It was also recorded of this animal by Milne-Edwards that when irritated it raised its dorsal crest erect and defended itself by biting vigorously.

Mr. Pocock concluded by remarking that the specimen exhibited, which before being skinned was perfectly fresh having been kept in a refrigerator, had a most peculiar but indescribable smell. From this it might be inferred that *Lophiomys* was perhaps a protected self-advertiser. On the other hand, it was considered possible that it might be a mimic of the Porcupine, since the coloration of the two was in a general way very similar*.

PAPERS.

41. On an Amphipod from the Transvaal.

By the Hon. PAUL A. METHUEN, F.Z.S.

[Received April 27, 1911: Read June 13, 1911.]

(Plates XLIX.—LI.†)

Introduction.

About twelve months ago, Mr. Hewitt, of the Albany Museum, Grahamstown, who, at that time, was at the Transvaal Museum, Pretoria, communicated in a letter to the Rev. Noel Roberts and to me, his discovery of a blind Amphipod together with some Copepods in a cave at Irene, which lies about 9 miles south of Pretoria; at the time of writing he considered the species to belong to the genus *Eucrangonyx* Stebbing. Owing to other work he postponed the description of it, and, when I came out some few months ago, he very kindly gave me the specimens collected to deal with.

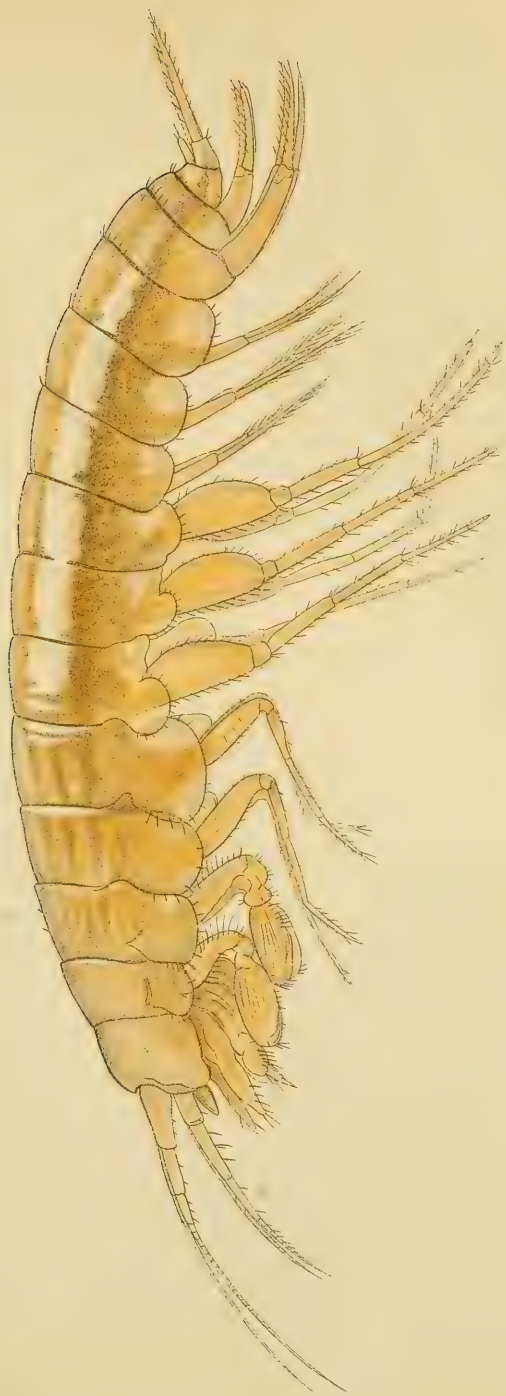
Not long ago I visited the same cave and secured two specimens: none of the Amphipods taken from this cave were large.

In February, Mr. Austen Roberts and myself went to the Makapan Caves, which lie in hilly country about 15 miles west of Potgietersrust, in the Transvaal, for we heard that some of these caves contained water, and we hoped to obtain a more plentiful supply of these cave Crustacea.

The first cave we visited—the more famous historically—contained nothing we were in search of, so we directed our steps to

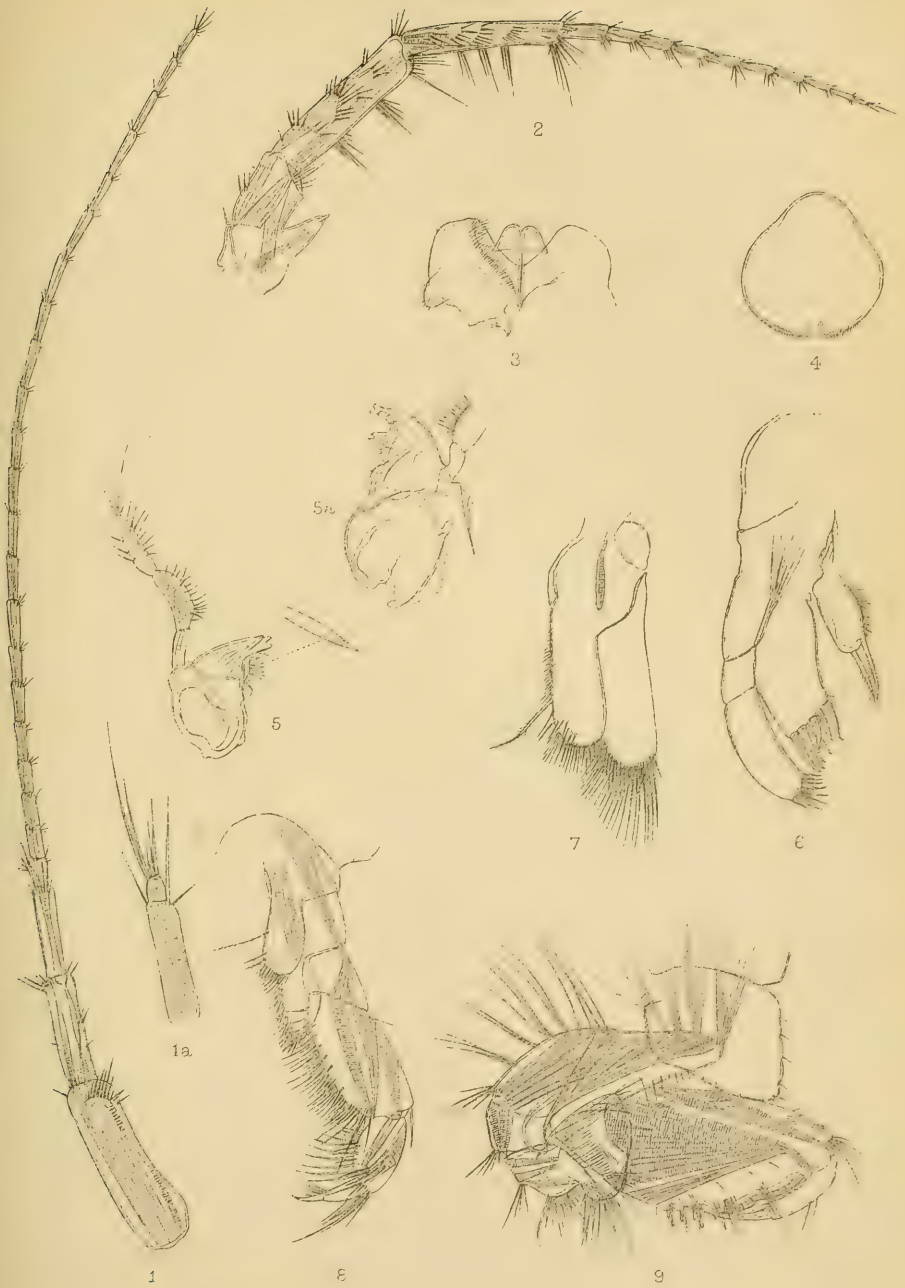
* In the discussion that followed this exhibition, Dr. R. E. Drake-Brockman, who was acquainted with *Lophiomys* in Somaliland, remarked that the natives of that country regarded these rats as young Porcupines.

† For explanation of the Plates see p. 957.



West, Newman chr.

EUCRANGONYX ROBERTSI.





West, Newman lith.

two others on the opposite side of the valley. In both we found a plentiful supply of water.

As to these two caves, one was considerably deeper than the other. In the first one we entered, we reached the level floor fairly soon; here we found shallow sheets of water supporting a large number of Gammarids, Copepods, and Ostracods; the bottom was muddy and the floor of the cave generally covered by the droppings of bats. No light entered as far in as this. The bottom of the second cave we reached after a rather long, steep, and winding descent: the stalactites and stalagmites showed it to be a limestone cave. The water here was as clear as crystal, rich in Gammarids and poor in Copepods; there were no Ostracods, but a few aquatic worms were taken; some terrestrial Isopods and some spiders were also found. Though the water appeared quite still, a fresh supply was without doubt being added continually. The bottom was rocky, covered by a thin layer of fine mud, and the floor of the cave, as in the other, was strewn with bat droppings.

Later in the day a few Gammarids, similar in every respect to the others taken, were caught under stones at a spring in the vicinity, but none were ever taken in the spruit which runs through the valley, where the numerous crabs would make short work of such fry.

All the Gammarids so far found in the Transvaal represent a single species, belonging most probably to the genus *Eucrangonyx* Stebbing, and closely related to *Eucrangonyx vejdoskyi* Stebbing, *vide* (3. p. 389 and 4). However, this little cave form has not been placed in this genus without notice being taken of certain resemblances and affinities to the genus *Niphargus* Schiödte (3. p. 405), more so to *Neoniphargus* Stebbing (3. p. 404 and 2, p. 73), and the genera *Crangonyx* Bate and *Paracrangonyx* Stebbing (3. p. 369 and 1. p. 218). In many ways this species appears to be a generalized *Niphargus-Crangonyx* type, as is seen mainly in the nature of the telson and third uropods; the breadth of the second joint of pereopods 3 to 5, and the total length of these appendages as compared to pereopods 1 and 2; the shape and size of the gnathopods; the number of setæ and spines on the inner and outer plates of the maxillula; the structure of the lips; the size of the accessory flagellum and total length of the antennule.

It is in the sense of the comparative generalization of its structure that this creature may be called primitive; primitive as opposed to the more recent genera *Paracrangonyx*, *Apocrangonyx*, and *Crangonyx*, but, on the other hand, more recent than the genus *Gammarus*, and probably *Niphargus*. This conclusion has been arrived at more by the study of the telson than of any other part (*vide* 1. p. 219).

The large size of the outer ramus of the third uropod appears to be almost peculiar, but, judging from Chilton's (1. p. 218) remarks on the variability of this element in *Crangonyx*, this character can be given apparently too much attention.

It may be as well to record the outstanding characters of this new species in order, and mention points of similarity and difference between it and the various genera and species mentioned above, as they appear significant in leading us to some conclusion as to the proper systematic position of the only known fresh-water Amphipod from South Africa (unless some littoral marine forms, taken in a stream in the Cape Peninsula and in vleis on the Cape Flats within two or three miles of the sea, be considered as true freshwater creatures).

The antennules are longer than the antennæ, the accessory flagellum small and 2-jointed, subequal to the first joint of the normal flagellum. In *Eucrangonyx vejdotskyi*, the second joint of the accessory flagellum is half the length of the first. In *Neoniphargus*, the accessory flagellum is 2-jointed, longer or shorter than first flagellular joint.

Upper lip rounded as in *Niphargus*, *Crangonyx*, etc.

Lower lip, inner lobes fairly small; in *Paracrangonyx* they are small; in *Niphargus* well developed; in *Crangonyx flagellula* Benedict, very small. Mandibular processes moderate; in *Eucrangonyx vejdotskyi* unusually prolonged.

Mandibles normal, dissimilar. Second joint of palp, subequal to third, is rather broad owing to convexity of inner margin; in *Eucrangonyx vejdotskyi* second joint broad, considerably longer than third; in *Paracrangonyx* third joint subequal to second, which is not expanded (in figure); in *Niphargus* third joint longer than second.

Maxillula: inner plate with two plumose setæ, outer with seven spines serrated on the inner side; two or three setæ to inner plate in *Niphargus* and *Neoniphargus*, the former with seven spines to the inner plate, the latter with six; in *Paracrangonyx* the same as for *Eucrangonyx robertsi*; inner plate of *Crangonyx* with six setæ, of *Eucrangonyx vejdotskyi* with four setæ.

Maxilla as in *Eucrangonyx*.

Maxillipeds as in *Eucrangonyx* (most probably), not unlike those in *Paracrangonyx*.

The two pairs of gnathopods as in *Eucrangonyx vejdotskyi*, but palm equal to hind margin; in *E. vejdotskyi* it is much shorter.

Pereiopods 1 and 2 slender and slightly shorter than succeeding pereiopods; in *E. vejdotskyi* they are "said to be slightly longer." Pereiopod 5 the longest. The second joints of all the pereiopods much as in *E. vejdotskyi*.

Pleopods normal; in *Paracrangonyx* slight and one-branched.

In uropod 1, peduncle a little longer than the equal rami; in *E. vejdotskyi* as long.

In uropod 2, rami slightly unequal, peduncle as long as shortest ramus; in *E. vejdotskyi* shorter than rami.

Uropod 3 has peduncle half the length of long outer ramus, inner ramus minute with single spine; in *E. vejdotskyi* peduncle half the length of outer ramus, inner ramus flattened, rudimentary, shorter than peduncle; in *Crangonyx* and *Paracran-*

gonyx uropod 3 not elongate, so also *Neoniphargus* which has inner ramus minute; *Niphargus* has outer ramus long, two-jointed, and the inner small.

Telson with emargination and almost square, as in *E. vejdoskyi*; in *Crangonyx* entire or partly cleft; in *Paracrangonyx* entire; in *Neoniphargus* partly cleft; in *Niphargus* deeply cleft.

This evidence seems sufficient to warrant the inclusion of this new species in the genus *Eucrangonyx* near the species *E. vejdoskyi*.

I have taken the opportunity here offered of naming the species after the Rev. Noel Roberts, in recognition of his enthusiasm for this branch of zoology.

Detailed description of the new species.

Family GAMMARIDÆ Leach.

Genus EUCRANGONYX Stebbing.

EUCRANGONYX ROBERTSI, sp. n. (Plate XLIX.)

Female: length of largest specimen taken 11 mm.*; colour dirty yellow or pink in the shallower cave near Potgietersrust, semi-transparent white in the deeper cave. No trace of eyes was discovered.

Body rather compressed, smooth, no carina, rostrum barely perceptible, a few minute spines on dorsal part of head and third segments; the last three or five segments with spines on posterior margin.

First four coxal plates of pereion deeper than the rest, the first smallest, the third and fourth deepest; the fourth plate broader than the others; side-plates of the fifth, sixth, and seventh pereion segments small, those of fifth and sixth deeply emarginate behind. These coxal plates bear marginally small spines.

Antennules (Pl. L. fig. 1) long, longer than the antennæ; flagellum much longer than the peduncle; first joint of the peduncle a little shorter than second and third joints together; second joint rather longer than third; accessory flagellum (Pl. L. fig. 1 a) two-jointed—both joints armed with setæ,—minute, hardly as long as first joint of flagellum; all the joints of the antennule provided at their distal extremity with moderate setæ, of which one or two on each segment are conspicuously longer than the rest; the second joint of the peduncle has also two groups of small setæ and one other seta besides about its middle length; the arrangement of the setæ on each joint of the flagellum appears to be constant in disposition after the eighth joint, and to be about seven in number.

Antennæ (Pl. L. fig. 2) about four-sevenths the length of the

* The length includes that part from the anterior margin of the head to the posterior margin of the last pleon segment.

antennules; peduncle longer than flagellum, the ultimate and penultimate joints well armed with numerous setæ which are arranged, generally speaking, in succeeding and nearly parallel semicrescents about all parts of the joints except the proximal extremities; on the other joints of the peduncle the setæ represent a much diminished quantity; the distal parts of the flagellum joints carry about eight setæ each, disposed in an unvarying sequence.

Lips: upper lip (Pl. L. fig. 4) rounded, with some minute setæ about the extremity, at the centre of which they take an inward course for a short way on each side. Lower lip (Pl. L. fig. 3): inner lobes with minute setæ on distal convex margins; outer lobes with longer setæ; mandibular process not elongate, bearing small setæ.

Mandibles (Pl. L. figs. 5 & 5 a): palp rather long when compared with the size of the mandible itself; first joint shortest, devoid of setæ; second joint rather broad and curved, the side opposite the biting process markedly convex and armed with two rows of setæ (about fifteen in number); the ultimate joint is about the same length as, or a little longer than, the penultimate and is provided with terminal setæ on both lateral margins. Palp on each side similar except that basal joints are of slightly unequal lengths. Mandibles themselves of unequal size and of slightly different structure (*vide* figs. 5, 5 a).

Maxillula (Pl. L. fig. 6) resembles that of *Paracrangonyx compactus* Chilton very closely. The first joint of the palp is short, the terminal joint bears about nine bristles; the endite of the third joint of the maxillula is armed with seven stout serrated bristles, which resemble those found in a similar position in *P. compactus* but differ in being more extensively serrated, and, further, at the base of the innermost of these bristles is found a group of fine hairs; this endite is about double as broad as the palp; the endite of the first maxillula joint (accepting Hansen's interpretation of the endites) appears to be exactly similar to that of *P. compactus*, bearing two fairly long plumose setæ and a number of hairs on its inner margin.

Maxilla (Pl. L. fig. 7): the endites are simple, regular, and well-developed structures, both armed distally with a great number of setæ which are disposed in two rows, the more distal of these rows being considerably longer than the rest, at any rate in the case of the endite of the third joint; the inner side of the endite of the second joint bears a number of fine hairs, and between these and the distal rows of setæ lies one long plumose and another smaller, slightly plumose seta.

Maxilliped (Pl. L. fig. 8): the shape of the joints like those of *Paracrangonyx compactus*, the whole limb being, however, somewhat slenderer; the seventh joint alone is shorter than that of *P. compactus*; a great number of closely-set setæ and bristles clothe the inner surface of the two endites and of the fifth, sixth, and seventh joints. The basipoditic endite or inner plate carries

three plumose setæ on its inner margin, and distally three short stout bristles and about eleven plumose setæ. The endite of the ischiopodite or outer plate carries a number of fairly short stout bristles distally, and along two-thirds of its inner margin six of the distal bristles are serrated.

Gnathopods: about the same size and length; the fifth and sixth joints of gnathopod I. somewhat broader than those of gnathopod II. In the male, gnathopod I. is a little longer than gnathopod II.

Gnathopod I. (Pl. L. fig. 9) well developed, subchelate; the coxa of the first joint in shape making almost a parallelogram, sloping forward somewhat, anterior portion deeper than posterior, diagonal from posterior ventral corner to anterior dorsal corner equalling greatest length of coxa; anterior margin bearing five small spines and ventral margin five also. The second joint or basos is narrow at the base, has anterior side straight, and bears six feebly serrated setæ, the most distal the longest; posterior margin convex, most markedly about the middle of the joint which is here seen to be two-fifths in breadth to length; the posterior margin carries a number of long setæ, and following this arrangement, four setæ proximally, equidistant apart, followed by a group of two, then a group of three, a group of two, another group of three setæ all serrated, and distally a group of four smaller setæ, not serrated. The third joint or ischium is short, broader than long, and bears on its posterior distal extremity five setæ not serrated. The fourth joint or meros has the posterior distal portion rounded and well provided with numerous serrated setæ, proximal to which lie a group of four serrated setæ; on the anterior margin four small setæ can be noticed. The fifth joint or carpus, which is more or less triangular, has a dense cluster of serrated setæ on its short posterior portion, which are arranged into groups, one consisting of a row of marginal setæ, another of apparently two rows placed submarginally; the anterior margin of the joint carries four setæ. The sixth joint or propodus is subovate, equal in length to the longest measurement of the basos, as wide as the greatest vertical depth of the coxa; anterior margin convex, with four groups of four fairly short setæ arranged at varying intervals from a fifth group of six longer setæ situated near the base of the dactylos; in addition, a small solitary seta will be noticed external to the third of these groups; the posterior margin, starting from the proximal end, is straight for a short distance, to a part where four small well-marked prominences are encountered; on each of these are placed two finger-shaped processes of unequal length and, excepting on the last prominence, two setæ; behind the fourth prominence lies a row of setæ: the palm, to which the dactylos fits closely, follows immediately; it is provided with a series of very short spines arranged in couples, each couple equidistant apart; a number of short setæ, nine in number, are also present opposite the border of the most posterior muscle, disposed more or less in a straight line, and varying

slightly in individual length; between the eighth seta of this series and the middle portion of the palp are placed three fairly long setæ, of which the central is the longest. The dactylos, which is slightly curved, is provided with two setæ on its anterior and four very short setæ on its posterior margin; this inner margin bears distally a small tooth distinct from the long curved terminal unguis; between these two lie two small setæ. None of the setæ on the ultimate and penultimate joints are serrated.

Gnathopod II. (Pl. LI. fig. 10) is very like gnathopod I. Only the chief differences will be mentioned. The setæ on the second joint are somewhat different in disposition and in length. The third joint is somewhat longer and narrower and possesses more setæ. The fourth joint has fewer setæ and only one fairly dense group of about ten setæ. The fifth joint is three-quarters as broad as long (the same measurements in gnathopod I. show the breadth to be greater than the length); the anterior and posterior margins are comparatively long, the former the longest; the setæ on the posterior margin are longer and more numerous and are arranged in seven or eight groups. The sixth joint has, on the anterior part, an additional group of fairly long setæ, which vary in number in each group: the whole joint is longer and narrower: the palm does not differ much, but the proximal half of the posterior margin bears eight groups of long feebly serrated setæ, between which and the palm lie five finger-shaped processes, one conspicuously longer than the rest with another little one at its base. The dactylos and terminal unguis spine are both shorter; between the latter and the small terminal tooth there are no setæ.

Pereiopod I. (Pl. LI. fig. 11): the coxa of the first joint is almost rectangular; the anterior and ventral margins are, however, somewhat concave, the middle part of the posterior margin slightly convex; the anterior margin has four short setæ, the ventral three. The second joint is long, narrow at the proximal base, whence it widens rapidly but nowhere greatly, being never more than a quarter as broad as long; nine spines of moderate length and seven spines of greater length arm its anterior and posterior margins respectively; further, a group of four setæ are placed at the distal extremity of the posterior margin. The third joint is a little longer than that of the gnathopods but is considerably narrower; its posterior margin carries a group of four setæ distally. The fourth joint is long, longer and broader than the fifth, the two joints together about the same length as the second joint: the anterior margin carries three setæ unequal in length—at the base of the longest a minute seta can be seen—and distally a group of three setæ, one of which is long; the posterior margin bears three groups of three setæ each, then one short seta, then distally a group of three setæ. The fifth joint, which is equal in length to, but broader than, the sixth joint, carries on its anterior margin two minute setæ, and

distally a group of three small setæ; the posterior margin is provided with four groups of setæ, the proximal group consisting of three setæ, the next of two, then another of two, the most distal group of four medium and one large seta. The sixth joint, which is slender, bears on its posterior margin six groups of three setæ to each group, and on its anterior margin three minute setæ, and distally a group of four setæ.

Pereiopod II. is practically similar in all respects to pereiopod I., to which it is subequal; on the second and third joints there are two or three small additional setæ marginally.

Of the *remaining pereiopods* the fifth is the longest, the third the shortest, these differences of length being appreciable but not great; they are, however, considerably longer than the first and second. In the third pereiopod, although the second and third joints are somewhat shorter than those of the first pereiopod, the great difference in length is made up by the much greater length of the fourth, fifth, sixth, and seventh joints of the third pereiopod; at the same time these four joints, though slender, are of the same breadth as those of the first pereiopod.

Pereiopod III. (Pl. LI, fig. 12): the coxa of the first joint is somewhat concave anteriorly, emarginate posteriorly; anteriorly and ventrally it bears some small spines. The second joint is rather narrow at the base, broadens very rapidly, and then narrows gradually towards its distal extremity; it is a little more than twice as long as broad; the anterior margin is slightly convex and is beset with a number of moderate spines—describing from the proximal end, three single ones equidistant apart, six in pairs subequidistant apart, and terminally a group of three spines: the posterior margin has fourteen shorter spines equidistant apart and terminally two closer together; behind these latter a large spine. The third joint is slightly rounded and carries a group of four fairly small setæ. The fourth joint is broader at the base than that of the first pereiopod; the anterior margin carries nine small setæ, arranged in pairs all but the most proximal, and distally a group of four setæ, one conspicuously larger than the others; the posterior margin carries two moderate spines and three small ones and distally two fairly large and two small spines. The fifth joint is armed with five groups of spines, the most proximal group of two, the next three of three, and the following of two spines to each group, and distally with a sixth group made up of two larger and two smaller spines; opposite the last group is a group of one larger and three smaller spines, some distance behind which is a single spine, and behind this spine again two groups of three spines, and disposed proximally to these a couple of small spines close together. The sixth joint is conspicuous on account of the larger size of some of the spines on its anterior margin; on this margin four groups of three spines to each are fixed, and distally a group of eight spines varying in length: on the opposite margin six groups of spines are seen, each group possessing two or three spines. The seventh joint, including the

claw, is one-third as long as that of pereopod I., and carries on the posterior margin two small spines.

In *pereopod IV.* the details of the arrangement of the setæ differ very slightly.

In *pereopod V.* the third and fourth joints are equal in length to, but broader than, those of the third pereopod; the seta arrangement is not exactly similar, but this slight difference is negligible. In Irene examples the penultimate joint of this appendage carries much longer spines on one side than is the case in specimens from the Makapan caves.

The *pleopods* are normal; the basal portion bears two branches and two little coupling-hooks. The longest pleopod is the second.

Pleopod I. (Pl. LI. fig. 13): basal portion oblong, slender, and devoid of setæ, except the two coupling-hooks; these little structures bear a few tubercles and one slightly hooked at the end. The inner ramus is somewhat longer than the outer; each ramus consists of thirteen joints which bear long plumose setæ.

Pleopod II.: the basal part bears distally on its anterior margin two fairly long spines, which are absent in the other pleopods and appear to be absent altogether in the male.

Pleopod III.: the number of joints to the rami are two or three less than those of the first pleopod.

The *uropods*: the first uropod the longest; the third uropod not quite so long as the first; the second uropod about two-thirds as long as the first. The peduncle of the first uropod long, longer than either ramus, much longer than peduncle of second; peduncle of second much longer than peduncle of third. Outer ramus of third uropod long, much longer than those of first; inner ramus minute. Rami of first uropod longer than those of second.

Uropod I. (Pl. LI. fig. 14): peduncle, broadest at the base, bears five spines on posterior margin, and two others close together distally. Outer ramus a trifle shorter than inner, which bears five spines on posterior margin and two larger and four smaller ones at the extremity. The outer ramus with four rows of spines, three in each row, and another row basally of two spines; distally two larger and two smaller spines.

Uropod II. (Pl. LI. fig. 15): peduncle fairly stout as compared with that of uropod I., narrower basally, but broader distally than same; on posterior margin two spines; on median ridge (*vide fig.*) five spines, the most distal being the longest. Inner ramus longer than outer, which carries on posterior margin four spines, and distally two longer and five shorter spines; anterior margin has two small spines; the outer ramus bears posteriorly four spines, two longer and three shorter distally, and eight spines arranged in couples anteriorly.

Uropod III. (Pl. LI. fig. 16): peduncle about the same breadth as that of uropod II.; anterior margin bears distally two small spines; opposite these is seen the inner ramus bearing one small spine, not counting spine it is one-fourth the length of the peduncle.

Anterior margin of outer ramus carries six groups of spines, three to each group except the two most distal, which are made up of two spines each; distally is a group of fairly long setae: the posterior margin shows five groups of spines, the first two groups of three spines, and the other three of four spines each. At junction of peduncle and outer ramus three spines can be distinguished. In the male the outer ramus appears to be hardly as large as in the female.

Telson (Pl. LI. fig. 17) almost square; sides slightly convex: two small plumose setae on each side bear two larger and two smaller spines placed in a posterior position. The structure excavate behind; in the male this excavation not quite so deep as in the female. In specimens from Irene one of the terminal spines on each side is much longer than in other specimens.

Literature referred to.

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3. STEBBING, T. R. R.—Amphipoda Gammaridea in Das Tierreich, 21 Lief. Berlin, 1906.
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EXPLANATION OF PLATES XLIX.-LI.

The appendages have been drawn with the aid of a camera lucida.

All the figures are of *Eucrangonyx robertsi*, ♀.

PLATE XLIX.

Side view of female, $\times 11$.

PLATE L.

- Fig. 1. Antennule, $\times 29$.
 1 a. Accessory flagellum, \times ca. 160.
 2. Antenna, $\times 29$.
 3. Lower lip, \times ca. 45.
 4. Upper lip, \times ca. 45.
 5 & 5 a. Mandibles, $\times 29$.
 6. Maxillula, $\times 75$.
 7. Maxilla, $\times 75$.
 8. Maxilliped, $\times 40$.
 9. Gnathopod I, $\times 29$.

PLATE LI.

- Fig. 10. Gnathopod II, $\times 29$.
 11. Pereiopod I, $\times 29$.
 12. Pereiopod III, $\times 29$.
 13. Pleopod I, $\times 29$.
 14. Uropod I, $\times 29$.
 15. Uropod II, $\times 29$.
 16. Uropod III, $\times 29$.
 17. Telson, $\times 29$.

42. An African Rhinoceros, Klipspringer, and Gazelle*.

By R. LYDEKKER †.

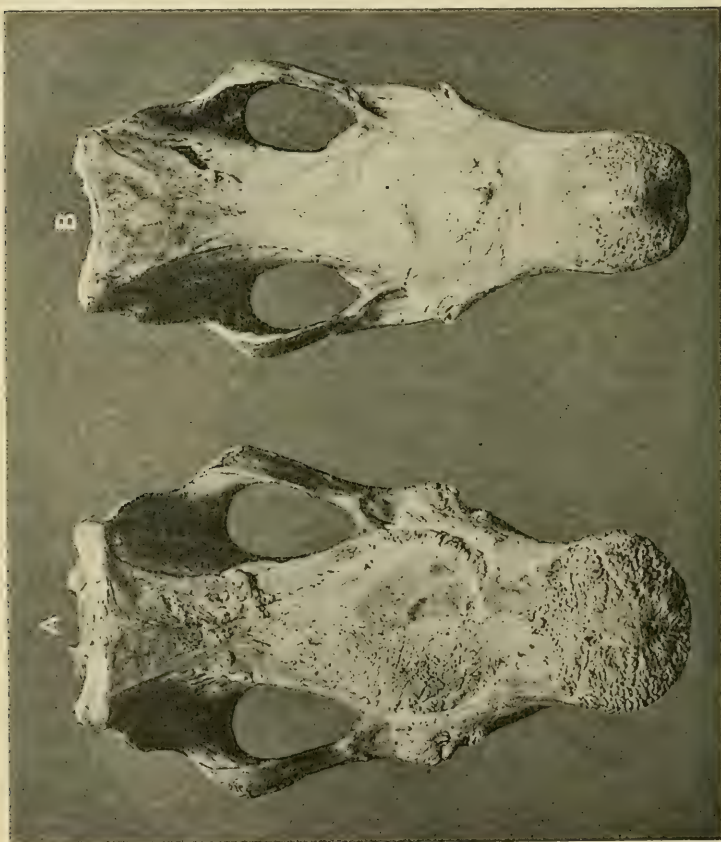
[Received May 9, 1911 : Read June 13, 1911.]

(Text-figures 191-193.)

I. THE SOMALI RHINOCEROS.

The presentation to the British Museum by Mr. Drake-Brockman of two skulls of the Somali Rhinoceros, affords an opportunity of considering whether that animal is entitled to rank as a distinct local race of the so-called black species. Sportsmen, I am told, almost invariably regard it in that light;

Text-fig. 191.



Upper aspect of skulls of East African (A) and Somali (B) Rhinoceroses.

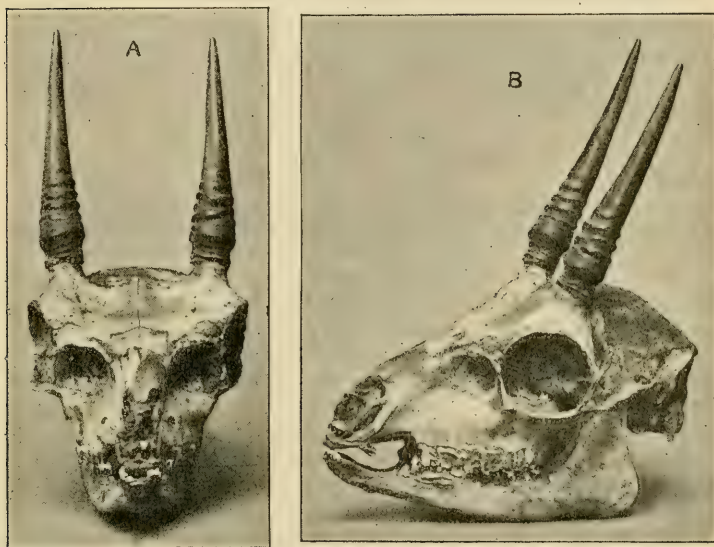
* The complete account of the two new forms described in this paper appears here, but as the names and preliminary diagnoses were published in the 'Abstract,' the species are distinguished by the names being underlined.—EDITOR.

† By permission of the Trustees of the British Museum.

and Mr. Ward informs me that such heads as he has mounted indicate a relatively small animal, with horns inferior in size to those of the Eastern and the Southern Rhinoceroses, and a skin with a somewhat different epidermal structure.

According to modern views in regard to nomenclature, the Somali Rhinoceros already has a scientific name, since it is referred to by Count Joseph Potocki on page 82 of his work entitled 'Sport in Somaliland,' London, 1900, as *Rhinoceros bicornis somaliensis*; and although no description was published at the time, the accompanying plates apparently render the name valid.

Text-fig. 192.



Front (A) and side (B) views of skull of Nigerian Klipspringer.

Of the two skulls presented by Mr. Drake-Brockman, one is that of a subadult animal, with the whole of the permanent dentition in use, and almost perfect, although the tip of the premaxillæ is broken off. The other, which is considerably more imperfect, is that of a younger animal, with the upper premolars only just coming into wear.

Compared with a skull of *Rhinoceros bicornis* from East Africa (B.M. No. 7.2.26.1)* (text-fig. 191), of somewhat greater age than either of the Somali specimens, the latter are seen at once to differ by the narrower form of the whole upper surface, both at the interparietal constriction and at the orbital expansion. The boss for the front horn is also much less expanded in the Somali skulls, and there is less convexity in the region immediately behind

* I am fully aware that this is not the type locality of the species.

this. Moreover, the palate is more decidedly vaulted in the Somali than in the East African skull. So far as I can ascertain, these differences appear to be constant in all the skulls available for comparison.

The differences in the proportions of the Somali and East African skulls will be apparent from the following table:—

	E. African.	Somali.
Length of upper aspect	22 $\frac{1}{4}$ ins.	23 ins.
Breadth at orbits	11	9 $\frac{1}{2}$
Palatal length	21 $\frac{1}{2}$	20 $\frac{3}{4}$
Zygomatic width.....	14 $\frac{1}{4}$	11 $\frac{3}{4}$
Length of upper tooth-row (excluding p. 1)...	10 $\frac{1}{2}$	10 $\frac{1}{4}$
Width of m. 2.....	2 $\frac{1}{2}$	2 $\frac{1}{4}$

As these dimensions amply demonstrate the racial distinctness of the two forms, the Somali animal may stand as *R. bicornis somaliensis* Potocki; the specimen here described occupying the position of type. It may be added that if the East African and Somali skulls were of the same age, the difference in the lengths of the upper tooth-row would be greater.

II. THE NIGERIAN KLIPSPRINGER (*Oreotragus saltator porteousi*).

Lydekker, Abstract P. Z. S. 1911, p. 38 (June 20).

Early in May, as I have already stated in the *Field* newspaper for that month, Mr. Rowland Ward directed my attention to the skull and horns of a male Klipspringer from the Duchi 'n Wai range of the Yola province of Northern Nigeria, lying to the south-west of Lake Chad. The skull was taken from an animal shot there by Dr. E. J. Porteus, by whom it was kindly placed at my disposal. Klipspringers, it appears, are quite familiar to the natives working in the Yola tin-mines, by whom they are known as *gaddi-dueki*, a term equivalent to Hill Duiker.

The skull (text-fig. 192) differs from that of an East African Klipspringer by its much greater width; its diameter across the orbits being 3 $\frac{1}{4}$ inches, whereas that of the East African specimen is 2 $\frac{5}{8}$ inches. It is further distinguished by the marked bending down of the margin of the lachrymal bone, which consequently has a distinct lateral surface in place of a sharp edge, and also shows only a comparatively small part of its total area from the frontal aspect.

Klipspringers, so far as I am aware, appear to be unknown on the West Coast north of Angola*; while to the north, Abyssinia is the nearest point to Yola where they are found. As the country between the last two districts is to a great extent low desert, the Yola Klipspringer must be quite isolated.

On this ground, and also on account of the peculiarities in the form of the skull, it is clearly entitled to racial distinction, and I propose to name it *Oreotragus saltator porteousi*, in honour of Dr. Porteus.

* For the information that Klipspringers inhabit Angola, I am indebted to Mr. E. A. Hamilton.

The type of the new race of Klipspringer will be the aforesaid skull, which Dr. Porteus has kindly presented to the British Museum.

I know of no Antelope with a distribution identical with that of the Klipspringer, as now extended.

About a fortnight after describing this skull I received a letter, dated Naragata, Northern Nigeria, from Mr. M. P. Hyatt, informing me that he had recently killed three Klipspringers—an adult buck and two does—in that part of the country.

III. AN ALGERIAN GAZELLE (*Gazella hayi*).

Lydekker, Abstract P. Z. S. 1911, p. 38 (June 20).

At the close of 1909, Mr. M. V. Hay presented to the British Museum the skin and skull of an adult male Gazelle, shot by himself in Algeria between Constantine and Biskra, and supposed to be a Dorcas (*Gazella dorcas*). In due course the specimen was set up, and placed on exhibition as a representative of that species. Recently, however, as already mentioned in the *Field* newspaper*, it was pointed out to me by the donor that the specimen differed considerably from the Dorcas, and I was informed at the same time that its distinctness is recognised by the Arabs, who call it *rhozal-rim*; *rhozal* being the name of the dorcas, and *rim* that of Loder's Gazelle (*G. leptoceros*). On comparison of the specimen with an undoubted Dorcas from the Biskra district, the difference between the two became apparent (text-fig. 193).

Mr. Hay's specimen is about the same size as a Dorcas, but appears to have rather larger ears,—I say appears to have, because one is never certain whether there may not have been stretching or shrinking in the mounting. Its most distinctive characteristic is, however, to be found in the form of the horns, which completely lack the double, sublyrate curvature of those of the Dorcas, and incline almost directly upwards and slightly inwards, with a slight inward and forward turn at the tips. There are also much fewer rings on the horns, the present specimen having only 12, whereas a Dorcas may have 24 or 25; possibly a more aged example of the new form might develop two or three more rings, but even then the difference would be very considerable.

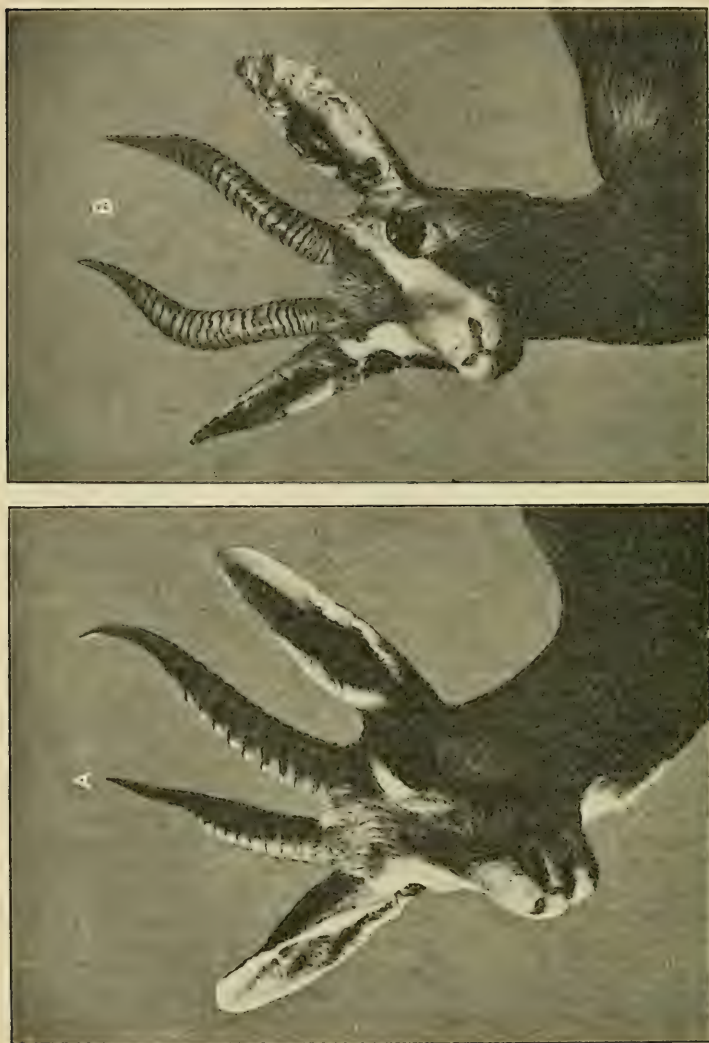
The face-markings differ considerably from those of a Dorcas, and are more like those of an Edmi (*G. cuvieri*); the middle stripe being much darker, with a conspicuous nose-spot, and the light eye-stripes much less apparent, while the forehead lacks the chestnut tint of the Dorcas. The body does not show the faint light stripe above the flank-band which occurs in the Dorcas; the knee-tufts are larger and blacker; and the tail is brown instead of black, with a shorter fawn area at the base.

As the skull of Mr. Hay's specimen is mounted in the skin, I cannot give cranial characters; but the foregoing features are amply sufficient to distinguish the new Gazelle from the Dorcas,

* June 3rd, 1911.

which is found much more abundantly in the district frequented by the former. This being so, there is no doubt as to the distinctness of the new species, which I have named *Gazella hayi*,

Text-fig. 193.



Heads of *Gazella hayi* (A) and *G. dorcas* (B): both from the Constantine-Biskra district.

from all other Algerian Gazelles, unless it be *G. kavella* and the so-called *Antilope corrina*, neither of which can now be identified. The type of the new species will, of course, be the Museum specimen.



A. Cabrera

Witherby & Co., Imp.

CAPRA PYRENAICA HISPANICA.
(Summer Pelage)





Witherby & Co, Imp.

CAPRA PYRENAICA VICTORIÆ ♂, ♀.
(Summer Pelage)



A. Cabrera

Witherby & Co., Imp.

CAPRA PYRENAICA VICTORIÆ.
(Winter Pelage)

43. The Subspecies of the Spanish Ibex.

By Prof. ANGEL CABRERA, C.M.Z.S.

[Received May 13, 1911: Read June 13, 1911.]

(Plates LII.-LIV.* and Text-figures 194-199.)

The first scientific description of a Spanish Ibex was that published in 1833 by F. Cuvier, in the great iconographic work 'Histoire Naturelle des Mammifères,' pl. 396. It was based on a young male from the Pyrenees, of which the author gave a beautiful figure in winter pelage, but was not accompanied by any technical name. In the index of the work, published in 1842, the animal is erroneously called *Capra ibex*, the fact being apparently ignored that four years before Schinz had described the same form of Goat under the name *Capra pyrenaica* †.

In volume xxvi. (1848) of the 'Comptes Rendus' of the Paris Academy of Science, Schimper briefly mentioned the Ibex of the Andalusian sierras, naming it *C. hispanica* and considering it as quite a different species, a view followed by all the authors of the time, and sustained still in our own days by Forsyth Major ‡ and Graells §. Modern zoologists, however, seem to agree in admitting only one species of Spanish Ibex, though admitting that there are some differences between the specimens coming from the Pyrenees and those from other parts of the Peninsula. Sclater || considers the latter as a "slightly altered phase" of the former; and Trouessart, in his 'Conspectus Mammalium Europæ,' expresses the same idea in a more modern fashion, describing two different subspecies: *Capra pyrenaica*, from the "chaînes des Pyrénées," and *C. pyrenaica hispanica*, from the "chaînes de montagnes de l'Espagne Centrale et Méridionale."

I do not intend to discuss now the meaning of the terms species and subspecies. While awaiting a satisfactory and universally accepted definition of these words, I agree with other authors in considering all the Spanish Wild Goats as belonging to a single species; but as to the number of subspecies, I think there are, not two, but three at least, the Ibex of Central Spain being quite different from both the Pyrenean and the Andalusian forms. This view has been anticipated by Ménégau in Perrier's 'Vie des Animaux,' as he says that "la forme qui habite les sierras du centre de la Péninsule fait le passage entre les deux formes susnommées" (*pyrenaica* and *hispanica*). This central subspecies remains, however, unnamed and undescribed as a different form, and to name and describe it are the chief purposes of the present paper.

* For explanation of the Plates see p. 977.

† Neue Denkschr. Allg. Schweiz. Ges. Nat. ii. 1833, p. 9.

‡ Atti Soc. Tosc. Sc. Nat. iv. 1879, p. 2.

§ Memorias Acad. Cienc. de Madrid, xvii. 1897, p. 356.

|| P. Z. S. 1886, p. 315.

Before doing so, I must remark on the geographical distribution of the species and on the differences between the various races.

In that interesting book 'Unexplored Spain,' MM. Chapman and Buck have quite recently told the history of the Wild Goats of Spain and the manner in which they are protected against imminent extinction, giving some details about their present distribution. The authors are not exact, however, in saying that the isolated colonies now formed by the Ibex have been "separated from each other during ages." There are, in fact, strong reasons for believing that in the past Ibexes inhabited every suitable point of almost every mountain ridge in Spain. Names recalling its existence, such as Las Cabras, Cabrales, Cabrera, Cabreira, Cebberos*, &c., are quite common in all the mountainous districts. In the seventeenth century the species was found in all the Sierra Morena and Sierra de Cazorla. The Sierra de Segura, Sierra de Francia in the Salamanca Province, and the Toledo Mountains, where it does not exist to-day, formed parts of its range sixty years ago, and it has been found in the Sierra de Bejar, between the Sierras of Francia and Gredos, so recently as 1897 †; and in 1861, the date of Seoane's 'Fauna mastológica de Galicia,' a few individuals remained in the mountains of that region. That Ibexes inhabited, or at least inhabited in 1890 ‡, the mountains of Gerez, in the northern border of Portugal, is a well-known fact.

In connection with the existence of Ibexes in the western extreme of the Cantabrian chain, it must be remembered that fossil remains of *Capra pyrenaica* have been found in Santander, and from this we may surmise that the species reached the north-western corner of the Peninsula from the Pyrenees, through that northern ridge. It spread from there southwards into the central sierras, either through Portugal by the Serra da Estrella, included in its range by Trouessart, or directly through the Burgos mountains and the Guadarrama. Father Saturio Gonzalez, a noteworthy collector of mammals, tells me that he has found in the old monastery of Silos a pair of Ibex horns which have been preserved there for centuries, and about sixty miles east from Santo Domingo de Silos there are a Sierra de Cabrejas and a village named Cabrejas del Pinar. These facts seem to suggest that the Ibex was once common in the mountains connecting the northern chain with the Sierra de Gredos, but, since there is not any evidence of its existence in the Guadarrama, too much confidence cannot be put in this hypothesis.

As to the Andalusian sierras, it is evident that the Ibex found

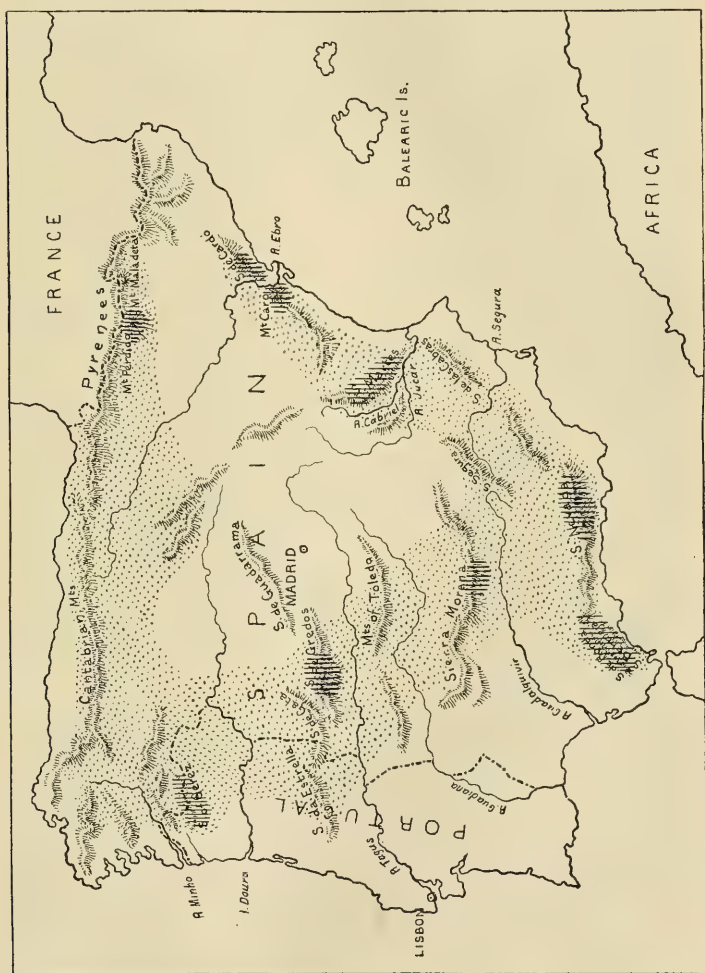
* *Cebra* was frequently used instead of *cabra* as a name for the Ibex during the twelfth and thirteenth centuries. It was from this that the old Spanish writer Father Sarmiento supposed that Zebras formerly existed in Spain. The modern vernacular name of the animal is *cabra montés* (Mountain Goat), or simply *montés*, but there are some other local names. In the mountains about the lower Ebro it is called *sauvatge* (the wild one); the people of Galicia call it *eraba brava* or *eraba fera* (Wild Goat), whereas in the Pyrenees the name *bucardo*, related to the English *buck* and the French *bouc* and *bouquetin*, is commonly used.

† Rivas Mateos, *Actas Soc. Esp. Hist. Nat.* 1897, p. 208.

‡ P. de Oliveira and L. Vieira, *Annaes Scienc. Naturaes*, iii. 1896, p. 91.

its way to them by the Toledo mountains and the Sierra Morena, turning afterwards along the mountainous ridges of Eastern Spain northwards to the lower Ebro basin. Notwithstanding the proximity of this region to the Pyrenees, I cannot believe that the Ibex inhabiting it immigrated directly from the Pyrenean chain, as it is very different from the form found here, and quite indistinguishable from the southern race.

Text-fig. 194.



In the geographical range of the Spanish Ibx four perfectly distinct areas may be distinguished, although now reduced to a number of small isolated colonies by continued persecution from

the Middle Ages, when wild-goat meat was a very favoured dish at every Spanish table. A different subspecies is found in each of these areas, as follows :—

(a) Pyrenean area, comprising the Spanish side of the Pyrenees and, in former times, the eastern part of the Cantabrian chain. Its peculiar Ibex is *Capra pyrenaica pyrenaica*. It may be considered as practically extinct, being today found only in the northern extreme of the Huesca Province, about the Mount Perdido*. Two old bucks, three females, and three or four half-grown individuals remained there in 1907†. In a recent letter on this subject, the Count of San Juan, who spends a great part of his time hunting in the Pyrenees, kindly informs me : "I think that probably no more than ten or twelve Ibexes remain in all the Pyrenean chain. A pair survived recently in the Maladeta; somebody shot the female, and the male sought refuge among a herd of domestic Goats and was subsequently killed by the goatherd."

(b) North-western, or Atlantic, area, formed by the mountains of Galicia and Northern Portugal. The lack of suitable material prevents correct identification of the Wild Goat found there, but from the description by Barboza du Bocage‡ I surmise that it represents a peculiar subspecies, which I do not care to describe at present. At all events, it is well-nigh extinct, only a few specimens, if any, remaining in the Portuguese mountains of Gerez. Not being a Spanish race, we need not discuss it now.

(c) Central area, embracing the Sierra de Gredos and, in the past, the ridges of El Barco, Bejar and Francia, and the hills of Toledo. The subspecies inhabiting this area, at present reduced to a single colony in the highest peaks of Gredos, will be named and described below. MM. Chapman and Buck have told the history of this Ibex so accurately that it is unnecessary to repeat it here. The colony consists of about three hundred and fifty head, and having been under royal protection since 1905 it is rapidly improving.

(d) Mediterranean area, from the mountains forming the Guadalquivir basin, eastwards and northwards through the sierras of the Valencia Province to the mouth of the Ebro. It is inhabited by *Capra pyrenaica hispanica* (type locality, Sierra Nevada), a subspecies not so near extinction as the Pyrenean and Central forms. No less than six colonies, in fact, are known to exist, the exact number of heads in each of them being unknown. Three of these colonies are in South Spain, viz. :—one in Sierra Nevada, another in the two parallel ridges of Sierra Bermeja and

* The Mont Perdu of the French. It is a custom with many English writers to use French names for localities on the Spanish slope of the Pyrenees, but, in my opinion, such a course is against commonsense. Since these localities are in Spain, Spanish names must be preferred in every case in which there is not an English name for them.

† Gourdon, Bull. Soc. Sc. Nat. de l'Ouest de la France, (2) viii. 1908, p. 12.

‡ Mem. Acad. Sc. Lisboa, 1857.

Sierra de Ronda from their junction in the Sierra de Tolox, and the third one in Sierra Morena, near Fuencaiente, under the protection of the Marquis of Mérito. Another community of *C. p. hispanica* is that of Sierra Martés, Valencia Province, mentioned by Chapman and Buck. It is very possible that Ibexes exist also in the mountains on the opposite bank of the river Cabriel, a name itself derived from "cabra"; but if such is the case, these Goats cannot be considered a different colony, since they may swim across the river, as a specimen now preserved in the collection of the Institute of Valencia was actually seen to do.

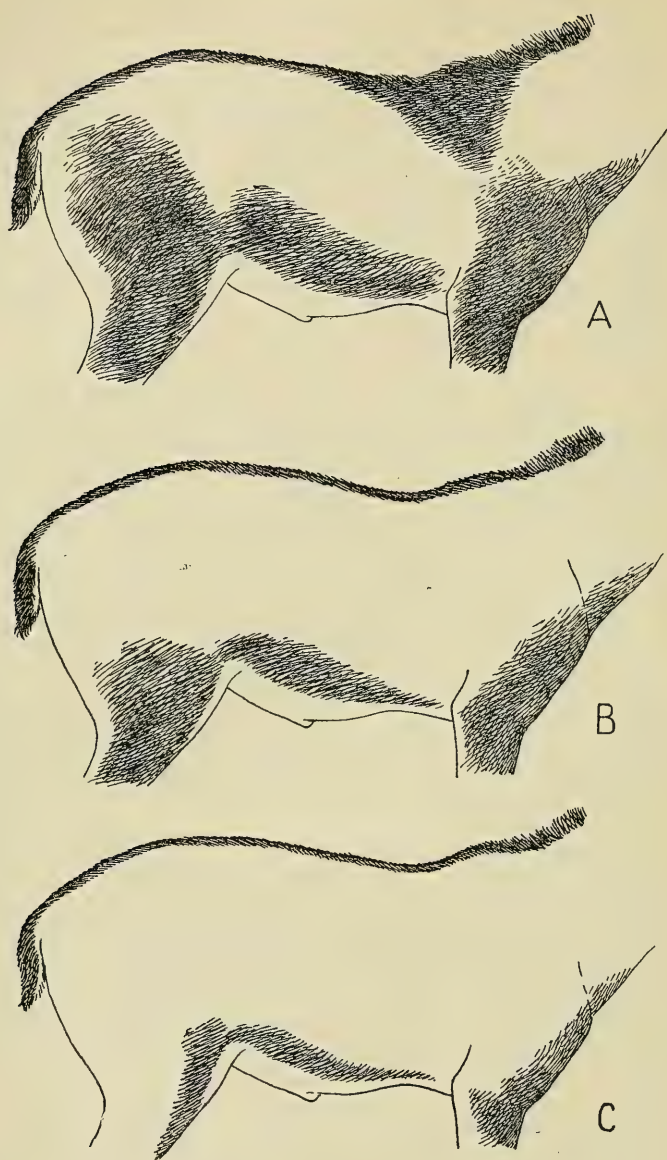
The two remaining colonies of this race are established on the lower Ebro, not far from Tortosa. One of these comprises the Sierra de Cardó and the Tivisa Mountains, where an immature male, recently received by the Madrid Museum, was obtained. The other colony is found on the other side of the river, on Mount Caro.

At first glance, the three subspecies of the Spanish Ibex are much alike, their chief differences being in the horns and in the extent of the black markings peculiar to these Goats. The species, as a whole, may be described as a pale brown animal with the outer side of the limbs black, a black band on the lower part of the flanks, and a short black mane, continued along the back by a narrow stripe. The forehead and the beard are blackish or very dark brown, and the belly and inner part of the limbs white. In winter pelage there is a whitish underfur, quite absent in summer, when the general colour is browner and the black areas become more abruptly definite. The females lack in all seasons the mane and the black markings of the head and body, presenting only a blackish tint on the anterior face of the limbs*, and it is the same with young males, in which the black areas appear in the second or third year, becoming larger and darker as the animal grows older. It is, therefore, very difficult to ascertain the differences between the various subspecies when quite adult males are not at hand.

In the typical *Capra pyrenaica* the dorsal line appears considerably broadened on the withers, frequently forming a large lozenge-shaped blot which in old specimens spreads laterally over the shoulders, coming downwards to coalesce with the black of the fore limbs. The black of the hind limbs extends upwards over the whole external surface of the thighs and on the hind-quarters, sometimes reaching the median stripe on the rump. The Mediterranean *C. p. hispanica* has these black areas considerably reduced, the dorsal stripe being not broadened anywhere, and the black of the fore limbs reaching at most the lower part of the shoulder and the chest, whereas on the thighs it does not reach the haunches and is narrowed to a mere band connecting

* In one of the illustrations in Chapman and Buck's 'Unexplored Spain,' representing the shooting of Ibexes in the Sierra de Gredos, the females are erroneously depicted with a well-marked dorsal line. In reality, this stripe is, in females and young males, very faint or quite obsolete.

Text-fig. 195.



Distribution of the black areas on the body of the Pyrenean (A), Gredos (B), and Mediterranean (C) races of the Spanish Ibex.

the band of the flank with the black of the leg, thus dividing the white of the inner side of the thigh from the general brown colour.

The Goat of Central Spain represents a stage intermediate between typical *pyrenaica* and *p. hispanica* by the spreading of the black areas, this colour invading the lower half of the shoulders and covering the whole outer side of the thighs, but not reaching the withers nor the haunches. The dorsal stripe, as in *hispanica*, is of practically the same width from neck to tail.

Text-fig. 195 clearly shows the gradual decrease in the amount of black as the species approaches the Mediterranean coast. The variation is to some extent parallel to that indicated by Lydekker* for the subspecies of *Capra sibirica*, but in the case of the Spanish Ibex it cannot be attributed to differences in elevation nor to the presence or absence of snow in the localities frequented by each race. I think it interesting to note that young males of *C. pyrenaica pyrenaica*, when two years old, closely resemble, in the black markings, adult males of the Central subspecies, the young of the latter being in turn similar to the adult *C. p. hispanica*.

As to the colour of the upper surface of the body, in winter pelage the three subspecies are much alike, the general tint being pale brownish grey in *C. pyrenaica pyrenaica*, dirty buff, more or less clouded with black towards the lower part of the flanks, in the Ibex of Central Spain, and a paler and less blackened buff in *C. p. hispanica*. The under side of the neck is black or dark brown in the Pyrenean and Central races, and slightly clouded with black in the Mediterranean form. I have never seen a specimen of true *pyrenaica* in summer pelage, but Trouessart describes its colour during that season as "gris brun foncé." In both the two other subspecies it is pale brown, washed with white on the flanks. There is, however, a difference of tint between them, the Central Ibex being browner and the Mediterranean one redder. The colour of the Ibexes of Gredos is near the broccoli-brown of Ridgway, whereas in *C. p. hispanica* it is a tint intermediate between fawn and cinnamon. Each hair is white at the root, after which there is an undulated space rather curiously coloured, as it has one side white and the other side brown. This particoloured space is followed by a broad pale band, and the hair ends in a dark brown point. Now, the difference in colour between the two subspecies depends on the pale subterminal space being entirely cream-buff in the Central Ibex, and white with a broad red ring in *hispanica*.

Another noteworthy difference between these two Ibexes is found in the colour of the hind border of the thighs. In the Central form this part is buff, abruptly contrasting with the brown of the haunches; whereas in the Ibex of the Mediterranean region it is coloured like the rump and the flanks, the tint being

* P. Z. S. 1901, i, p. 91.

only a little paler. Moreover, the sides of the head, grey in the Pyrenean and Central races, are pale buff, clouded with brownish red, in the Mediterranean form.

Text-fig. 196.



Skull and horns of adult male of the Gredos Ibex ($\times \frac{1}{2}$).

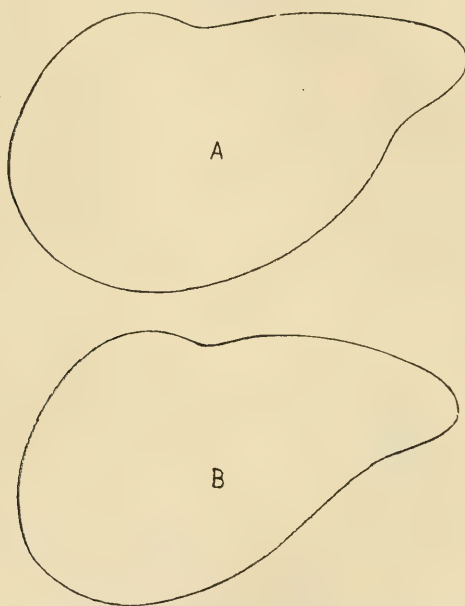
Madrid Museum, No. 1523.

The skulls of *C. pyrenaica pyrenaica* and *C. p. hispanica* have been described by Forsyth Major, who gives a number of differential characteristics, most of them, I think, either merely individual or due to age. A reliable one appears, however, to be found in the shape of the nasals, which are more abruptly narrowed in front in *hispanica* than in true *pyrenaica*. In this respect the Ibex of Gredos is nearer to the Mediterranean race, the border of the nasals forming an almost perfect V in their distal third.

Writing of the horns of Ibexes from different localities, Chapman

and Buck* assert that "examples from the two outside extremes (Pyrenees and Nevada) most closely assimilate in their flattened and compressed form of horn." If by this a lateral compression is to be understood, my own experience bears out this statement; but if we must understand that the individual horn in the Pyrenean and Mediterranean races is flatter from front to behind than in the Gredos subspecies, on careful inspection I cannot agree with the above-quoted authors. The only reliable method for

Text-fig. 197.

Cross-sections of left horns of the Gredos Ibex ($\times \frac{2}{3}$).

A. Madrid Museum. Type.

B. Madrid Museum, No. 447.

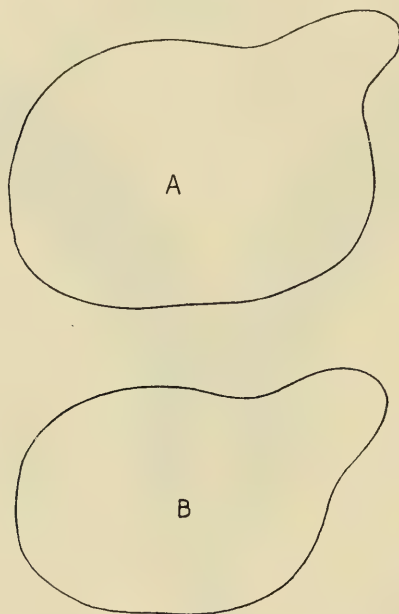
(In this and the two following figures the sections represent the horn as being seen from the tip, the front face appearing above and the inner keel to the right side.)

investigating the true differences, and the one I have followed with every specimen examined, consists in the taking of a cross-section of the horn about the middle of its length. This section is pear-shaped, and somewhat variable even in specimens from the same locality; but in each subspecies it is always easily referable to a peculiar type. Now, in the Gredos Ibex (text-fig. 197) it is

* 'Unexplored Spain,' p. 144.

invariably flatter and broader than in any one of the other subspecies, the difference being chiefly due to the great width, in the former, of the flat upper surface of the inner keel, between its edge and the round part of the horn. The horn sections of *C. p. pyrenaica* and *C. p. hispanica*, although much alike in their more rounded and narrow contour, also differ in form. In true *pyrenaica* the portion of the upper or front face immediately above the keel is markedly hollow, whereas in *hispanica*

Text-fig. 198.

Cross-sections of left horns of the Pyrenean Ibex ($\times \frac{2}{3}$).

A. Mainz Museum. Type.

B. Toulouse Museum.

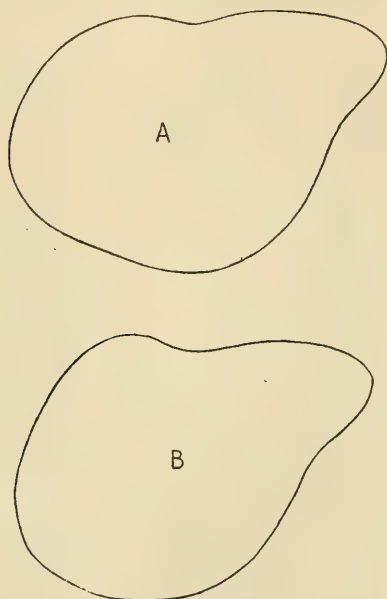
it is slightly convex, the Mediterranean Ibex approaching in this the Gredos subspecies. Of course, these differences can be appreciated only in adult males, as the horns of the young in all the races have a somewhat rounded section with a short projecting tip corresponding to the inner keel. Every specimen I have compared has horns with at least six annulations*.

As to the curvature and direction, the horns are absolutely alike

* The popular belief that each knot or annulation on the horns means a year in the age of an Ibex is no more true than the one assigning the same value to the tines of deer; but, since the number of knots depends on the horn growing, it becomes evident that many annulations, like many tines in deer horns, always indicate an old animal.

in the three races, being twisted in a half-turn of spiral, with the tips sometimes directed inwards and downwards, as in *Capra cylindricornis*, but generally pointing upwards. Thus, the horns, when seen from the front, form a very open lyre, not unlike the lower half of the horns of the Pir Panjal Markhor. In the females they are very short, somewhat lyrate and quite cylindrical, differing from those of young males in the complete absence of keel. The size of the horns in the adult male is decidedly larger in the Pyrenean Ibex, the two other subspecies being practically

Text-fig. 199.



Cross-sections of left horns of the Mediterranean Ibex ($\times \frac{3}{2}$).

A. Madrid Museum, No. 449.

B. Madrid Museum, No. 1042.

similar in this respect. I have neither seen nor found mentioned any specimen from either Central Spain or the Mediterranean area with horns about one metre in length, such as frequently occur in Ibexes from the Pyrenees. There follows a table of horn-measurements of adult males in the three subspecies. The dimensions of specimens marked [Ch. & B.] after the owner's name, are converted into millimetres from Chapman and Buck's 'Unexplored Spain'; those of specimens marked [W.] from Rowland Ward's 'Records of Big Game.'

Pyrenean Ibex.

Length on outside curve.	Basal circumference.	Tip to tip.	Locality.	Owner.
mm.	mm.	mm.		
1020	260	...	Valibierna.	Bagnères de Luchon Museum.
970	...	...	North Spain.	Paris Museum.
830	...	...	Ordesa Valley.	Bordeaux Museum.
787	222	675	Ordesa Valley*.	Sir Victor Brooke [Ch. & B.].
750	260	450 (about) †	Pyrenees.	Mainz Museum (Type) ‡.
730	255	585	Ordesa Valley.	Sir Victor Brooke [Ch. & B.].
698	255	495	Pyrenees.	British Museum [W.].
630	250	...	Benasque.	Nantes Museum.
610	...	...	Pyrenees.	Paris Museum.
590	...	...	Querigüëña.	Toulouse Museum.

Gredos Ibex.

815	252	690 †	Gredos.	H.M. the King of Spain.
768	240	595	Central Spain.	MM. Chapman & Buck [W.].
740	250	530	Boboyo.	Madrid Museum (No. 447).
730	220	470 †	Gredos.	Madrid Museum (No. 1523).
715	245	620	Gredos.	Marquis of Torrecilla.
700	165	520	Gredos.	Señor Prado Palacio.
680	245	520	Las Hoyuelas.	Marquis of Viana.
650	260	550	Madrigal de la Vera.	Madrid Museum (No. 448).
630	260	540	Las Hoyuelas.	Marquis of Viana.
613	230	...	Gredos.	MM. Chapman and Buck [Ch. & B.].

Mediterranean Ibex.

850	...	...	Sierra Morena.	Marquis of Mérito [Ch. & B.].
740	200	525	Sierra Nevada.	Madrid Museum (No. 449).
730	230	585	Sierra Nevada.	MM. Chapman and Buck [Ch. & B.].
650	...	...	Sierra Nevada.	Bordeaux Museum.
590	220	320	South Spain.	Señor E. Cortina.
590	210	470	Sierra Nevada.	Madrid Museum (No. 921).
580	200	...	Sierra Nevada.	Madrid Museum (No. 1043).
580	200	...	Sierra Nevada.	Mainz Museum.
570	250	410	Sierra Nevada.	Madrid Museum (No. 1042).
555	200	415	Sierra Martes.	Señor P. Burgoyne [Ch. & B.].

* MM. Chapman and Buck give merely "Pyrenees" as the locality of Sir Victor Brooke's specimens, but according to a letter of the owner himself, published by Count Russell (see Gourdon, Bull. Soc. Sc. Nat. de l'Ouest de la France, viii. 1908, pp. 6-8), they were obtained in Ordesa Valley, the Val d'Arras of the French.

† The tip of a horn is slightly broken.

‡ *Capra pyrenaica* was based by Schinz on specimens in the Mainz Museum, which are still there, as Dr. Reichenow kindly informs me. One of these specimens being an adult, although not old, male in winter coat, and the winter pelage being described first by Schinz, I think it convenient to choose it as the type.

I must now proceed to the complete description of the Central Spain Ibex. His Majesty King Alfonso XIII. has specially and graciously permitted me, at my own request, to dedicate this subspecies to Her Majesty Queen Victoria of Spain. I have great pleasure in doing so, in recognition both of her love of nature and of the fact that Royal protection only has prevented the total extinction of this splendid ruminant.

CAPRA PYRENAICA VICTORIAE, subsp. n.

Diagnosis.—An intermediate form, in size and in the extent of the black markings, between *C. p. pyrenaica* and *C. p. hispanica*, rather browner than *hispanica* in the summer coat, and with horns similar in size to those of that race, but comparatively broader and flatter.

Colour.—Adult male, summer pelage: Upper surface of body pale broccoli-brown, sometimes inclining to raw umber, and more or less white-washed on the sides. Neck fawn-coloured, paler, and frequently whitish, on the under surface. A black stripe, bordered with white hairs, starts from a large black blot covering the nape and runs along the upper part of the neck and over the back, reaching to the tip of the tail. On the neck the hairs of this stripe are long and erect, forming a short mane. On the back the white hairs form a narrow and not very distinct light area on both sides of the black median line. Belly and inner side of thighs white. A broad black band, grizzled with white at the borders, crosses obliquely the lower part of the flanks, its anterior point going into the white of the underparts. Thighs black, except on the hinder border, which is light buff. The black spreads downwards, encircling the limb above the hock and covering the front and sides of the leg and the whole foot from some distance above the false hoofs. The fore feet and the front and lateral surfaces of the fore limbs are likewise black, this colour reaching the lower half of the shoulders, the chest, and the lower part of the ventral aspect of the neck, where it is coarsely mixed with white. Back of the legs creamy white. Forehead seal-brown; cheeks brownish grey; the eyes encircled with ochraceous buff, and the muzzle and the upper lip are of the same colour. The beard brownish black, this dark tint covering also the sides of the lower jaw to the rim of the mouth, whereas the middle of the lower lip is dirty white. The ears fawn-coloured on their outer aspect, yellowish white within.

Winter pelage: The main colour of the upper parts of the body and neck turns in winter a dirty buff, densely clouded with black on the flanks, the hairs being white at their bases and then pale cream-buff with a brown or blackish tip, and covering a whitish under-fur. Throat and underside of the neck seal-brown, touched here and there with chestnut. Black areas distributed as in the summer coat, but not so abruptly defined, their upper borders melting into the black clouding on the sides. The colours of the head are practically the same as in summer, the cheeks only being slightly paler and somewhat buffy.

Adult female: In summer pelage the general colour is an intermediate tint between cinnamon and fawn, paling to creamy white on the underparts, the inner side of the limbs, and the lateral and hinder surface of the legs. The muzzle and the sides of the face cream-buff. The fore part of the legs, from a short distance above the knees and hocks, Vandyk-brown. Tail like the back, with a seal-brown tip. Dorsal stripe and bands of the flanks quite absent. In winter coat the main colour is a dark dirty buff.

Young of both sexes, in the first year: Colour like adult females, but somewhat paler; the markings on the legs pale chestnut. The males begin to show the dark areas of the body in the third year, the black tint appearing first on the chest and lower part of the shoulders.

Skull and horns.—See above for the comparison between this and the other subspecies.

Measurements (of type, mounted).—Length from nose to root of tail, along the curves, 1355 mm.; tail, 130; hind foot, with hoofs, 385; ear, 120; height at shoulder, 700*.

Skull (of paratype, Madrid Museum, No. 1523): Total length, 264 mm.; interorbital breadth, 110; length of nasals along median suture, 95; greatest width of ditto, 40; upper molar series, 68; lower molar series, 75. For the horn-measurements, see the foregoing table (p. 974).

Type.—Old male in summer coat, from Madrigal de la Vera, on the southern slope of the Sierra de Gredos. Madrid Museum, No. 448.

The differences between this subspecies and both the typical and the Mediterranean forms of *C. pyrenaica*, fully discussed above, will be, I hope, clearly shown by the accompanying figures and plates. I have considered it unnecessary to give a coloured figure of the Pyrenean form, as there is a tolerably good one in Lydekker's 'Wild Oxen, Sheep, and Goats,' besides the portrait of a young male in Cuvier's 'Histoire Naturelle des Mammifères.' Unfortunately, the same cannot be said about *C. p. hispanica*. The figure published by Schinz in 'Monographien der Säugethiere' is anything but good, and the one in Rosenhauer's 'Thiere Andalusiens' is not much better, the rigidity and other defects of the mounted specimen, after which it was evidently made, being too faithfully reproduced by the artist. As for the Ibex of Central Spain, in Graells' 'Fauna Mastodológica Iberica,' there is a plate which appears to be an attempt to represent some of the specimens in the Madrid Museum; but they are figured in quite a grotesque and childish way, and the colour is entirely false. The Ibexes on the Risco del Fraile in Chapman and Buck's 'Unexplored Spain' are correctly drawn; but the illustration, being uncoloured, cannot give a complete idea of the animal.

* In an old buck from the Sierra Nevada, in the Madrid Museum, the length from nose to root of tail is 1190 mm.; the hind foot, 305.



1. MADOQUA PHILLIPSI GUBANENSIS. 2. MADOQUA PHILLIPSI HARARENSIS.
3. MADOQUA PHILLIPSI.

West, Newman chromo.



1. MADOQUA PIACENTINII. 2. MADOQUA SWAYNEI.

I must not close this paper without expressing my sincere acknowledgments to Prof. Dr. Reichenow, Mainz; Dr. A. Ménégau, Paris; M. A. de Montlezun, Toulouse; and M. Chaine, Bordeaux, for helping me with measurements and other information about specimens in their respective museums.

EXPLANATION OF THE PLATES.

PLATE LII.

Capra pyrenaica hispanica.—Adult male from the Sierra Nevada, in summer coat. Madrid Museum of Natural Science.

PLATE LIII.

Capra pyrenaica victoriæ.—Old male (type) from Madrigal de la Vera, and adult female from Bohoyo, both in summer coat. Madrid Museum of Natural Science.

PLATE LIV.

Capra pyrenaica victoriæ.—Old male from Bohoyo, in winter coat. Madrid Museum of Natural Science.

44. On Antelopes of the Genera *Madoqua* and *Rhynchotragus* found in Somaliland. By R. E. DRAKE-BROCKMAN, M.R.C.S., L.R.C.P., F.Z.S.

[Received and Read June 13, 1911.]

(Plates LV. & LVI.*)

THE DIK-DIKS.

The Somali country might justly be termed the home of the Dik-diks, for not only are most of the known species found there but all the remainder at present known, save *Madoqua damarensis*, are to be found in the adjoining territories.

These little Antelopes, affording but poor sport for the big-game hunter, have been quite overlooked by the sportsman until the last fifteen years or so.

Dik-diks are invariably found in what might be termed the acacia bush country, dry and arid regions where the trees seldom grow beyond the height of bushes, and where there is sufficient thick undergrowth to afford them protection, while at the same time it permits of their running about freely between the bushes and plants. In the dense aloe and sansevieria patches so frequently met with in these parched regions, Dik-diks will nearly always be plentiful, owing to the excellent shelter they afford for these diminutive creatures.

Most of the small plants and bushes supply them with food, but the various varieties of stunted acacias are undoubtedly their favourites. Personally I cannot recall having met with Dik-diks in any place where these stunted acacias were not to be found.

* For explanation of the Plates see page 984.

It has been doubted whether they can exist without water; Swayne says, talking of all the Dik-diks, that they "like to be near water, going to drink at midday and just after nightfall," whereas the Somalis maintain that if a Dik-dik drinks water it will die.

In the Badminton Library, vol. i., 'Big Game Shooting in East Africa,' Mr. F. J. Jackson wrote concerning the Paa, the local name for *M. kirkii*, "it is therefore quite evident that the juices of the vegetation on which it feeds and the dews at night are sufficient for its requirements."

My own experience is in entire agreement with the last-mentioned authority, although I am not prepared to say that Dik-diks never drink.

Those who may have observed them closely will have noticed how a single pair will, even though disturbed, be found day after day in much the same spot, perhaps a square acre in extent, miles from the nearest water; here they will live all their lives if unmolested. It is surprising to see how, after shooting the female, the male will cling to his old haunts, living quite alone for months together.

On one occasion I shot the female of a pair which used to live in a small acacia grove where I frequently went to get a Francolin for the pot; not wanting the male I left him alone, and shortly after left the district for seven or eight months, on the lapse of which I returned, and while after Francolin again saw my old friend who, not having found another mate, was living quite alone; there was no question about his being unaccompanied, as I saw him every time I visited the spot. This is all the more remarkable, as Dik-diks were plentiful enough in the locality.

There is one point I should like to emphasise before proceeding to deal with each of the various species in turn, and that is the presence, in a large proportion of the Dik-diks, of small white spots on the muzzle.

Professor Lönnberg has given specific rank to a *Rhynchotragus* from Lake Baringo because of this peculiarity, but I venture to think that this feature will not be found to be constant. In specimens of *M. phillipsi* from the same district some will be seen to possess these white muzzle-spots, while in others they are absent.

MADOQUA PHILLIPSI Thos. (Pl. LV. fig. 3.)

Phillips' Dik-dik presents such striking variations in different localities that for some time past I have been endeavouring to get together a series of specimens which will show these variations clearly and enable me to decide as nearly as possible the limits of this interesting species.

In point of fact, were it not for the skull-measurements being so similar, I should have been tempted to give each of the varieties distinct specific rank, as the localities frequented by each are very clearly defined.

Phillips' Dik-dik was first described by Mr. Oldfield Thomas,

who took as the type a specimen obtained by Mr. Lort Phillips at Dobwein, 40 miles south of Berbera.

This spot I have been unable to locate, so can only conclude, after carefully examining the type specimen, that it was somewhere along the Golis foothills or, perhaps, just on the top of Mirso, which I will show is the southerly limit of the coast or Guban variety, to which I gave subspecific rank in July 1909* and called *M. phillipsi gubanensis*.

This subspecies is found all along the coast-belt of British Somaliland, passing northwards into French Somaliland, certainly as far north as Djibouti, but how much farther I have been unable to ascertain, and eastwards towards the Mijertain country, but how far I have not yet determined, owing to there being no specimens available from that area.

What I propose to designate as the true *M. phillipsi* is the brilliant rufous or dark cinnamon-flanked Dik dik found throughout the interior of British Somaliland from, roughly speaking, the Golis Range away to the south and west into the Haud, where, especially in the west, the animal's flanks are so red that at a short distance it looks rufous all over; this is in marked contrast with the coast variety, which looks quite grey.

As one passes through the hilly country from Jig-jigga to Harrar and also to the west and south-west of the former, one finds another and darker Dik-dik, which in its wild state looks of a dark red-brown colour. This is the Dik-dik to which Mr. Neumann gave the name *M. hararensis*, and so distinct does it appear in life from *M. phillipsi* that it fully deserves a name so that it might not be confounded with *M. phillipsi*; but in my opinion it deserves only subspecific rank, and should be called *M. phillipsi hararensis* (Pl. LV. fig. 2). It is to be expected that in localities where the soils are so distinct as in the coast-belt and the Haud one would see some variation in the coloration of the pelage, and here in this species we have this variation very distinctly marked; but this is not the only difference, another equally potent factor, in the shape of altitude with its accompanying variations in temperature, also assists in increasing the difference between the type species and its subspecies, by rendering the pelage thicker.

For instance, the hair in the Guban variety is scantier and shorter than in the Harrar and neighbourhood specimens; in the former the individual hairs from the dorsal region of the back measure from 13–23 mm., whereas in the latter variety they are usually 30 mm. or more. This difference renders *M. phillipsi gubanensis* a much more sleek-looking animal (Pl. LV. fig. 1). The pelage of the true *M. phillipsi*, which is the common Dik-dik found all over the interior of the "Horn of Africa," is intermediate between the two.

The skull-measurements in all three are, as one would expect, practically identical.

* Ann. & Mag. N. H. ser. 8, Vol. 4. p. 49.

This Dik-dik is known to the Somalis by the name "Gol ass," owing to its bright red flanks. It ranges from near Djibouti in the north and the Ennia Galla country in the west throughout the Somali country to the east coast and as far south as probably the 3rd parallel. A large number of the skins of this Dik-dik are brought down to the Benadir ports for sale, from Central and East Central Somaliland.

I might here add that I consider that little importance can be attached to the colour of the crest, as it is very variable. In some it is of a bright fulvous, in others of a dull reddish brown, while in not a few the hairs are tipped with black. The white eye-patch also varies in distinctness with age.

MADOQUA SWAYNEI Thos. (Pl. LVI. fig. 2.)

This is the smallest of the Somali Dik-diks, and is, according to Swayne, known to the Ogaden Somalis by the name "Guyu," but this name I have never heard it called myself. The word "Guyu" in Somali means any living animal.

There is very little known about the exact habitat of this little Dik-dik, owing to the fact that sportsmen have usually confounded it with the ubiquitous *M. phillipsi*. The type specimen was bought by Swayne from a native in the town of Berbera.

I have been on the look-out for it for some years, but have failed to come across it either alive or dead in British Somaliland. I first met it during my journey with the Anglo-Abyssinian Boundary Commission in 1908, south of Ginir on the river Web, one of the affluents of the Juba, where it was plentiful practically all along the left bank of this river up to its junction with the Ganale. This I took to be its westerly limit.

One of my collectors has lately brought me two specimens of a Dik-dik from Eastern Somaliland, as far south as Obbia on the coast; he obtained these from a place called Gharabwein about 12 miles inland from Obbia, where they were plentiful, and were the only Dik-diks seen, although at Eil Hur, not more than 10 miles distant, *M. phillipsi* abounded and this Dik-dik resembling *M. swaynei* was absent.

From the above I conclude that *M. swaynei* and the above-mentioned species which I am about to describe stretch right across Central Somaliland from east to west, where they are locally distributed, and surrounded by the commoner *M. phillipsi*. Neither *M. swaynei* nor the allied form go as far south as Mogadishu, as my collector was unable to procure a specimen of either species there or on the Webi Shebeleh, nor was he able to purchase any of their skins in the market, although the Somalis bring Dik-dik skins in thousands for sale in the coast towns in Italian Somaliland. The only two species the skins of which he was able to obtain were *M. phillipsi* and *R. guentheri*.

The Obbia specimens differ from those I obtained on the Web in Western Somaliland in that there is no yellow suffusion of the

grizzling on the back in the former, as there is in the latter, and the bright rufous nose-patch is not continuous with the crest, which may be either rufous or dull earthy brown.

In his 'Game Animals of Africa,' page 191, Mr. Lydekker says, speaking of *M. swaynei*, "The bucks weigh but 6 lbs. and the does even less." Now it is an invariable rule among these small antelopes to find the females heavier than the males. There is usually a difference of 1 lb. between the sexes. Adult males of Swayne's Dik-dik weigh about $4\frac{1}{2}$ lbs. and the females 5 or $5\frac{1}{2}$ lbs., whereas the average weight of a buck of *M. phillipsi* is $5\frac{1}{2}$ lbs. and of a doe $6\frac{1}{2}$ lbs. The heaviest buck of the latter species I have ever weighed was $6\frac{3}{4}$ lbs., whereas the heaviest doe was 8 lbs.

I should place the range of this Dik-dik between the 5th and 9th parallels of latitude, where, although it intermingles with *M. phillipsi*, it is not nearly so common. It is quite possible that it is not to be found farther north than the 8th parallel, as Mr. Dodds, a friend of mine, shot a large number of Dik-diks in the Ogaden Rer Ali country, especially around Daggahbur and Milmil, and failed to procure a single specimen of *M. swaynei*, although both *M. phillipsi* and *R. guentheri* were obtained.

MADOQUA PIACENTINII, sp. n. (Pl. LV1. fig. 1.)

Although this little Dik-dik agrees, as regards its size and skull-measurements, with *M. swaynei*, it differs so markedly in coloration that I have considered it advisable to propose a new name for it.

In *M. swaynei* the grizzling is very indistinct, being invariably suffused with a dull buff or clay colour, whereas in this species the grey grizzling is so fine and distinct that it at once attracts attention.

The coloration of the legs in both species is similar. The neck in *M. piacentinii* is fairly grizzled all round, the pale throat and buff chin patches being completely cut off from the pinkish buff of the chest. Apart from the fine grey grizzling, the most distinctive patches are about the head.

In *M. piacentinii* there is a bright rufous diamond-shaped nose-patch which stands out conspicuously on the grizzled head, while the terminal part of the long hairs of the crest in both my specimens is of a dull creamy buff. The hairs of the crest, however, vary so much in Dik-diks that little importance can be attached to this feature. The ears, which are of a dark buff, have a very distinct black edging on the outside, about 4 mm. in width anteriorly and dwindling down to a mere edging posteriorly. This peculiarity I have never seen in any of the other Somali Dik-diks.

I was successful in getting only two specimens of this very handsome Dik-dik, both males, but both present exactly similar features. They were obtained by one of my collectors at a place

called Gharabwein, within a day's march of Obbia in the Mijertain country, Italian Somaliland. They were inhabiting thick aloe scrub country, and were plentiful in a locality some little distance from water; they were very local and appeared to be surrounded by *M. phillipsi*.

The following are the measurements in the flesh of the type specimen—a male in the British Museum, No. 356.

Head and body	475 mm.
Tail	37 "
Hind foot	137 "
Ear	62 "
Weight	4½ lbs.

Skull-measurements.

Total length	92 mm.
Basal length	80 "
Posterior edge of orbit to gnathion	65 "
Upper cheek-teeth.....	32 "
Length of nasals.....	16 "
Breadth of nasals	8.5 "

In comparing the above skull-measurements with a typical *M. swaynei*, it will be found that they are practically identical.

This bright and beautiful Dik-dik I propose to name in honour of my friend Mr. Piacentini, the Acting Consul-General for Italy in Aden, through whose kindness and help I was able to send my collector to the Mijertain country.

RHYNCHOTRAGUS GUENTHERI Thos.

This Dik-dik, known to the Ogaden Somalis by the name "Ghussleh" or "Gussuleh," owing to its habit, when startled, of dashing off in leaps and bounds, giving vent to a peculiar whistling cry which sounds like "Ghuss-Ghuss-Ghuss," is chiefly found in Western and West Central Somaliland. Swayne tells us that he first met with it when travelling in a south-westerly direction in the Rer Amaden country, *i. e.*, roughly speaking, between the 7th and 8th parallels of north latitude; this is its northerly limit, as Mr. J. H. Dodds tells me that during a recent journey he made in Western Somaliland he never met this Dik-dik until he got to Daggahbur, a well-known Ogaden watering-place near Milmil.

Starting from Daggahbur in the north this Dik-dik passes in a southerly and south-westerly direction for Dolo at the junction of the Dawa and Ganale rivers, and then crossing the Juba is ubiquitous throughout north-eastern British East Africa. I do not think it reaches the coast anywhere, being there replaced by *R. kirkii*. In Somaliland proper its easterly and south-easterly limits are still unknown.

It probably extends for a considerable way down the Webi

Shebeleh river, very nearly reaching to the coast in the Hawiya country, as thousands of their skins are yearly sold in the market in Mogadishu by the Hawiya Somalis. They are either caught in native traps or shot with bow and arrow.

RHYNCHOTRAGUS KIRKII Günth.

Kirk's Dik-dik, which was named so far back as 1880, inhabits only the most southern angle of the Somali country east of the Juba River; it, however, extends across that river and southwards into British East Africa as far as Kilimanjaro. How far north it extends into Somaliland proper I am unable to say, as the material at present available is insufficient.

The type specimen came from Brava on the Benadir coast of Italian Somaliland, but my collector failed to get me any specimens from Mogadishu, so I conclude that it does not extend farther north than this, being replaced on the coast by *M. phillipsi* and in Central Somaliland by *R. guentheri*, of which hundreds of skins are offered for sale in the market in Mogadishu. I have only been able so far to procure the skins without head-skins or skulls from that locality, so am unable to definitely state whether the skins belong to *R. guentheri* or an allied form; they certainly appear to agree with my specimens of the former.

RHYNCHOTRAGUS CORDEAUXI Dr.-Br.

This Dik-dik, which was named by me last year, should really be included among the Abyssinian Dik-diks, together with *R. erlangeri*, *M. phillipsi hararensis*, and *R. guentheri wroughtoni*, but like *M. phillipsi hararensis*, it will probably be found to inhabit the north-eastern part of the Esa country.

It was first obtained by me in the bush country to the west and north-west of Dirre Dawa, and is at present, so far as I am aware, recorded only from the Danakil country:

I traced it as far west as the Gurgurra River, one of the tributaries of the Hawash, and it is this latter river that marks out its westerly limit; the northern edge of the Harrar and Arussi plateaux mark its southern limits, but how far north and north-east it strays I am at present unable to definitely state.

This is a fine species, and most resembles in appearance *M. phillipsi gubanensis*, only it is a much bigger animal.

RHYNCHOTRAGUS ERLANGERI Neum.

Erlanger's Dik-dik hails from Eastern Abyssinia. As one descends from the great Arussi plateau on the low-lying country, towards the east, called by the Gallas "Gamogi," this is the Dik-dik one finds.

If a line be drawn on the map between Harrar in the north and Ginir in the south, this line will cut through an acacia-bush

country, more or less intersected by rivers and streams which drain the great Arussi plateau; this, the Ennia Galla country, is where Erlanger's Dik-dik is found.

The type specimen was obtained at Sheikh Hussein, which is 30 or 40 miles or so east of the edge of the plateau, while my own specimen was obtained some 20 miles to the west of Sheikh Hussein opposite the foothills of Mt. Abu el Kassim, on the south bank of the river Wabi.

So far as I am aware, these are the only two specimens recorded, so that at present its limits must remain undefined; but I fancy I shall be fairly accurate in suggesting that its habitat probably lies to the west of the Harrar-Ginir line, being replaced to the east of it by *M. phillipsi hararensis* and to the south by *M. swaynei*.

RHYNCHOTRAGUS GUENTHERI WROUGHTONI Dr.-Br.

I have now come to a very interesting subspecies, namely *R. guentheri wroughtoni*. The only specimen recorded is the type, which I obtained on the north bank of the Wabi River among the foothills of Mt. Abu el Kassim.

The presence of this subspecies in a spot so far removed from the natural habitat of the species can only be explained by its having at some period or other found its way up the river Wabi, which is one of the main tributaries of the Webi Shebeleh, which flows through the vast area inhabited by *R. guentheri*. Its darker coloration and large ears are probably accounted for by its environment, namely the dense acacia bush on the banks of the river; the size and shape of its ears certainly point to this.

I am inclined to think that this subspecies will only be found close to the river, as both *M. erlangeri* and *R. swaynei* are to be found within a short distance of it.

EXPLANATION OF THE PLATES.

PLATE LV.

Fig. 1. *Madoqua phillipsi gubanensis*. | Fig. 2. *M. phillipsi hararensis*.

Fig. 3. *Madoqua phillipsi*.

PLATE LVI.

Fig. 1. *Madoqua piacentinii*. | Fig. 2. *Madoqua swaynei*.

EXHIBITIONS AND NOTICES.

June 27, 1911.

FREDERICK GILLET, Esq., Vice-President,
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of May 1911 :—

The registered additions to the Society's Menagerie during the month of May were 445 in number. Of these 163 were acquired by presentation, 200 by purchase, 41 were received on deposit, 25 in exchange, and 16 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 204.

Amongst the additions special attention may be called to the following :—

1 African Rhinoceros (*Rhinoceros bicornis*) ♂, from Nairobi, received from R. B. Woosnam, Esq., C.M.Z.S., for H.M. THE KING's African Collection, on May 19th.

1 Californian Sea-Lion (*Otaria californiana*) ♀, from the North Pacific Ocean, purchased on May 10th.

2 Three-coloured Parrot-Finches (*Erythrura trichroa*), new to the Collection, from New Guinea, received in exchange on May 4th.

A Collection of 38 Fishes, received on May 1st, comprising the following species, all new to the Collection :—

4 Sword-tails (*Xiphophorus helleri*) from Mexico, 2 Fighting Fish (*Betta splendens*) from Singapore, 2 Fan-tailed Cyprinodons (*Rivulus flabellicauda*) from Mexico, 2 Elegant Cyprinodons (*Haplochilus elegans*) from the Niger River, 2 Chaper's Cyprinodons (*Haplochilus chaperi*) from Sierra Leone, 2 Timid Cyprinodons (*Haplochilus panchax*) from Cochin India, presented by P. Arnold, Esq.; 2 Poey's Cyprinodons (*Rivulus poeyi*) from Para, 6 Ocellated Cyprinodons (*Rivulus ocellatus*) from Santos, 10 Zebra Fish (*Dania rerio*) from Bengal, presented by G. A. Boulenger, Esq., F.Z.S.; 2 Freshwater Flying-Fish (*Pantodon buchholzi*) and 2 Gular Cyprinodons (*Fundulus gularis*) from the Niger River, and 2 Rainbow Fish (*Trichogaster labius*) from Bengal, purchased.

Mr. D. SETH-SMITH, F.Z.S., the Society's Curator of Birds, exhibited two immature Black-backed Porphyrios (*Porphyrio melanotus*) which had been bred in the Gardens, and remarked upon their possession of a well-developed claw (text-fig. 200, p. 986) on the pollex. Although these wing-claws were said to be functional only in the Hoatzin amongst living birds, the exhibitor believed that they were so also in the present species and also probably in

the Common Moorhen, these birds using them in climbing amongst reeds and herbage.

Text-fig. 200.



Wing of young *Porphyrio melanonotus* with well-developed claw.

Mr. J. LEWIS BONHOTE, M.A., F.Z.S., exhibited a pair of Egyptian Desert-Mice (*Meriones crassus*) which showed a darker and more rufous colour than normal examples. This coloration had been artificially produced by keeping the animals in a moist atmosphere at 80° Fahr. They were first exposed to these conditions on the 7th of April, and a month later were conspicuously darker; after that the darkening process still continued, but more slowly, and they appeared for some time previous to being killed to have reached a limit to their darkening. During this same period, and owing to the fine weather, other examples had been in a temperature that rose during the day to 90°, falling at night to 60° or even lower. This had apparently produced no change in their coloration. The change in the examples exhibited was therefore probably due rather to the humidity than to the temperature of the atmosphere. Mr. Bonhote was therefore inclined to think that the pale colour of desert animals was due to the extreme dryness of the atmosphere rather than to any special assimilation of their colour to the surroundings.

Dr. W. T. CALMAN, F.Z.S., exhibited a number of living specimens of the Brine Shrimp (*Artemia salina*), bred from Tidman's Sea Salt. The Brine Shrimp, a small Crustacean

belonging to the Sub-class Branchiopoda, was found in various parts of the world, living in salt lakes and in the shallow ponds in which sea-water is exposed to evaporation for the manufacture of salt. It formerly occurred in England, but had probably long been extinct in this country. An accidental observation recently made at the Natural History Museum showed, however, that it was a very easy matter to obtain a supply of living specimens. "Tidman's Sea Salt," as sold in the shops, frequently, if not always, contained living eggs of *Artemia*, and an 8 % solution, allowed to stand for a few days, was found to contain a swarm of nauplius larvæ. The first attempt at rearing these failed owing probably to lack of food-material in the water. The juice of green leaves pounded in a mortar and strained through muslin was found to be a suitable food, and the addition of a few drops of this at intervals of about a week enabled the specimens exhibited to be raised to maturity. All of them were females, and swarms of larvæ of the second (parthenogenetic) generation had appeared.

The SECRETARY remarked that on a recent visit to the Ostrich Farm of Mr. Carl Hagenbeck at Stellingen, near Hamburg, he had seen in the incubator fertile eggs of *Struthio massaicus* from German East Africa, *S. australis* from South Africa, and *S. molybdophanes* from Somaliland, the eggs all having been laid at Stellingen. A. Reichenow ('Die Vögel Afrikas,' vol. i. p. 7) had already described and figured certain specific differences in the number and arrangement of the pits on the eggs of these species. He himself had been interested to notice that the eggs of the Masai Ostrich were much larger than those of the others, more spherical in shape, and very smooth and porcelanous in texture. Those of the Cape Ostrich were somewhat similar in shape and texture, but were much smaller; Mr. Hagenbeck had informed him that a pair of the Masai Ostrich bred by himself and sent out to the Cape were regarded by expert ostrich farmers there as unusually large birds. The eggs of the Somali Ostrich were larger than those of the Cape Ostrich, but smaller than those of the Masai species, and were markedly oval in shape with a rougher, less polished surface.

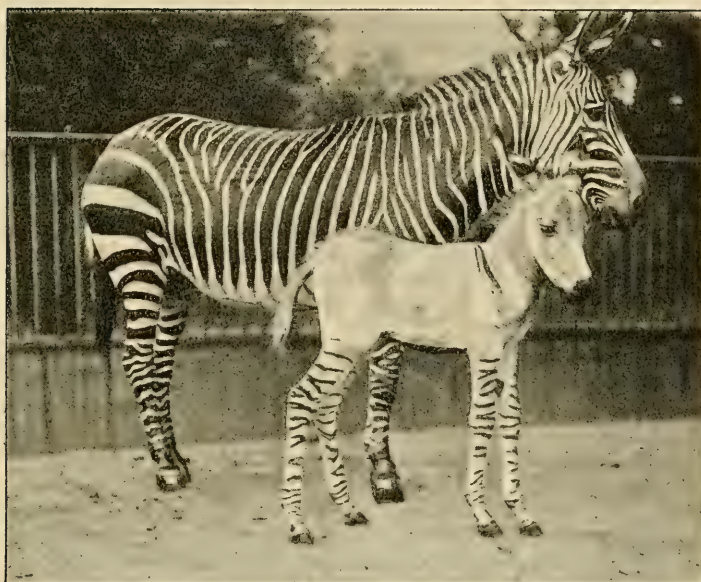
The SECRETARY also remarked that on his recent visit to Mr. Hagenbeck's Zoological Park at Stellingen, near Hamburg, he had the pleasure of seeing a fine young pair of the common African Rhinoceros, obtained from British East Africa, the exact locality being unknown. The male closely resembled the ordinary figures and mounted examples of the species, in that the skin appeared to be smoothly stretched over the sides of the body, but the ears were fringed with long tufts of hair. The female, on the other hand, had no hair on the margin of the ears, and the general external appearance was very different. At first sight it seemed

as if it were in very poor condition, the ribs standing out through the skin, but closer inspection showed that in reality the skin of the flanks was disposed in thick, permanent folds, arranged roughly like ribs. Thinking it possible that these differences might indicate the existence of distinct races of the Rhinoceros, on returning to London he had at once examined the Society's own pair of examples of this species, both of which had come from British East Africa, probably somewhere near Nairobi. The female, purchased in 1906, had the ears unfringed with hair, like those of Mr. Hagenbeck's female, but the rib-folds on the skin were no more than indicated, although there were very heavy permanent folds round the neck. In the male, obtained in the current year from Nairobi as part of the King's African Collection, the ears were fringed with hair as in Mr. Hagenbeck's male, whilst the rib-like folds on the skin were extremely strongly marked, as in the case of Mr. Hagenbeck's female. The presence or absence of the marginal fringe on the ears was therefore probably either an individual or a sexual character. In the absence of knowledge of the exact provenance of all the four examples, nothing could be said as to whether or no the presence of the rib-like permanent folds on the body were racial. Their existence, however, as well as the presence of the heavy fold round the neck, showed that it was not correct to distinguish the Asiatic Rhinoceroses from those of Africa by the presence in the former of permanent skin-folds. The neck-fold was almost identical in both, whilst, although they were differently arranged, deep body-folds occurred in both.

Mr. R. I. Pocock, F.R.S., F.Z.S., Superintendent of the Society's Gardens, exhibited a photograph (text-fig. 201) of a foal born in the Gardens on June 21st and bred between a male Somaliland Wild Ass (*Equus asinus somaliensis*) and a female Mountain Zebra (*Equus zebra*) and made the following remarks:—

“The period of gestation, dating from the day of service to the birth, was $12\frac{3}{4}$ months. The general colour of the foal is sandy fawn, the ground tint of the legs being markedly whiter. The ears are long, as in both parents, and have a large apical black patch, fading inferiorly in front to brown, and a brown transverse basal stripe, running upwards mesially; a corresponding basal stripe is present on the ear in the dam but not in the sire. There is no white tip to the ear such as is seen in all Zebras. The lips and area round the nostrils are black, and there is no white on the muzzle, such as is seen in all typical Asses. Half-way between the forehead and the muzzle there is an area covered with many close-set narrow brown stripes and some very faint stripes are traceable on the lower edges of the under jaw. The mane is like that of the sire (text-fig. 202), black in the centre and sandy fawn externally, the pale external portion showing no trace of breaking up into evenly spaced tufts, such as are seen in

Text-fig. 201.



Mountain Zebra and hybrid foal.

Text-fig. 202.



Somaliland Ass, the sire of the hybrid foals.

all Zebras. A narrow black spinal stripe extends from the mane to the black tip of the tail, but it is indistinct over the hind quarters and on the upper side of the tail where the hair is long, and recalls the dorsal and caudal mane or crest seen in the foal of Grévy's Zebra. There are a very distinct black shoulder-stripe and a few abbreviated stripes both in front and behind it; there are also indistinct traces of close-set stripes on the lower border of the neck and a deep black belly stripe; but for the rest the body is unstriped and of a tolerably uniform sandy fawn colour all over, like that of the sire. Both front and hind legs are marked with strong black stripes, broader and more numerous than in the sire but much less numerous and more widely spaced than in the dam. On the inside of the legs they extend just above the knees (*carpus*) and hocks (*tarsus*), but externally those of the hind leg reach almost to the stifle-joint (*knee*), while those on the front leg reach to about the same height. The callosities on the front leg are of medium size, being much smaller relatively than in the dam, but actually of about the same size as in the sire; and, as in the latter, there is no dewlap and the hairs along the spine project backwards.

In general appearance this foal, which is a female, decidedly favours the sire on account of the absence of stripes on the body and the sandy fawn ground-colour. But it may be noted that in the presence of the spinal stripe, the shoulder-stripe, and the stripe on the base of the ear, it shows much greater similarity to the typical form of African Ass, as exemplified by domestic breeds, than to the race to which its sire belongs.

Whether the stripes will become more numerous as age advances, remains to be seen.

This appears to be the first record of the birth of a hybrid between the Somaliland Ass and the Mountain Zebra. Several crosses between the domestic Ass and this Zebra have, however, been described. The best extant account was given by F. Cuvier (*Hist. Nat. Mamm.* iii. pl. 315, 1824), who accurately described and figured a hybrid produced by a male black Spanish Ass and a female Mountain Zebra. This animal agreed very closely with the one just born in the Gardens, except that the ground colour, when the animal was fourteen years old, was dark grey even on the legs and there were distinct spots on the basal half of the tail. The distribution of stripes was practically the same in the two; and Cuvier's figure shows no dewlap on the throat. The extension of a crest of hair along the spine from the mane to the tail and the presence of the basal stripe on the ear were noticed by this author. The difference between this specimen and the one born in the Gardens in colour of the body and legs is probably to be explained by the blackness of the coat of the sire; but St. Hilaire, who saw the foal when newly born, mentioned that its general colour was yellowish chestnut; at two years, however, it was grey and this tint was retained until death. The period

of gestation was a fortnight over twelve months, being shorter by one week than in the case of the animal born in our Gardens.

Another hybrid of the same kind is figured on plate 28 of the volume on Horses in Jardine's 'Naturalist's Library.' The animal seems to have been much more copiously striped than our specimen. Many strong but abbreviated stripes are shown running along the saddle behind the withers; the leg stripes extend farther up the quarters and the body, head and neck are marked with indistinct wavy and close-set stripes. The croup, however, seems to have been self-coloured sandy fawn like the rest of the body. In this case it is not known which of the two species was sire and which dam.

In the 'Knowsley Menagerie,' p. 73, two hybrids between Mountain Zebra mares and Asses of African descent are described. One sired by a Maltese Ass is represented by the right figure of the pl. lvii. The ground-colour of the body is dark grey, that of the belly and legs white; the face below the eyes is tan, and there is no white on the muzzle; the ears are large with the tip broadly black and a broad stripe near the base; the mane is grey and unstriped. There are no stripes on the face; but the body and neck are covered with narrow wavy stripes which break up into small spots upon the hind quarters; the shoulder-stripe is very distinct, broader than the others and forked; the belly is unstriped, but the legs are distinctly striped. Except for the presence of spots on the croup, this animal is rather like those figured in the 'Naturalist's Library.'

The second specimen, sired by an ass of unspecified breed, is described as grey with an indistinct cross and a few narrow dark stripes on the shoulder and fore legs [nothing is said about the hind legs]; the upper side of the tail, which is elongate and tufted, is stated to be slightly banded; and the ears are said to be moderate. Attention is drawn to the presence of scarcely any stripes on this animal, which is contrasted on that account with the one sired by the Maltese Ass. Although according to the text and the legends of the plates, this animal is unfigured, the description applies very closely to the specimen represented by the left-hand figure of pl. lvii., which purports to be a hybrid between a male Hemione (=Onager) and a female Zebra.

This figure represents an animal sandy fawn in colour with the legs striped, but somewhat sparsely, only slightly higher than the level of the belly which is lighter than the flanks; the head is fawn with some narrow close-set rufous stripes in the middle about half-way between the eyes and the nostrils; the muzzle is ashy grey, without any white; the ears are moderately long, with a black tip; the mane is black in the middle, white externally, the white hairs showing a decided tendency to break up into tufts as in all zebras and quaggas; continuous with the black mane is a black spinal stripe; there is a distinct black shoulder-stripe, followed by several abbreviated and less distinct stripes upon and

just behind the withers. In the text this animal is merely described as having the shoulders and legs banded. Its resemblance to the hybrid just born in the Gardens is very close and, indeed, surprising considering the difference in coloration and general character between the Onager and the Wild Ass of Somaliland. In our hybrid, however, the ears are decidedly longer and the mane shows no signs of being striped. Apart from these differences, there is little to choose between the two. But these differences are sufficient to make one hesitate in adopting the suggestion that the animal described as a hybrid between an Onager and a Mountain Zebra may have been a hybrid between a Domestic Ass and a Mountain Zebra."

[Supplementary note added July 4th, 1911.]

Since the above given account was read a hybrid foal (text-fig. 203) between the same Somaliland Wild Ass and a Chapman's Quagga (*E. quagga chapmanni*) has been born. The period of gestation was twelve months and four days from the date of

Text-fig. 203.



Chapman's Quagga and hybrid foal.

service. The foal is very like the Mountain Zebra hybrid. The ears, however, are smaller, as was to be expected from the relatively smaller ears of the Quagga dam. The ground colour of the body, too, is a little paler, while the legs are only slightly paler than the body. The leg stripes are less distinct and less numerous and the insides of the legs are scarcely banded. The

shoulder-stripe is shorter and simpler; the spinal strip is black and zig-zag over the saddle, and very faint, short, narrow, close-set stripes are detectable on each side of it along the back and elsewhere on the body, the hairs of these 'ghost-stripes' being a shade darker and glossier than the spaces between them. The spinal crest is not so pronounced; the apical black patch on the ear is smaller, and the basal stripe, although much narrower, is decidedly blacker. Faint narrow stripes are present on the nose as in the first described hybrid; the lips and area round the nostrils are black, and the two patches above the nostrils which are dark tan in the dam are dark greyish brown in the foal, and somewhat sharply contrasted with the narrow lighter area that intervenes between them and the general sandy grey hue of the nose.

The left-hand figure of pl. lviii. of the 'Knowsley Menagerie' represents a hybrid between a Domestic Ass and a Burchell's Quagga (*E. quagga burchelli*). This hybrid appears to differ from the one above described in having a few quite distinct brown stripes on the body and very few stripes on the legs. The ground colour of the legs, moreover, is markedly whiter. Since Burchell's Quagga differs from Chapman's in having the legs whiter and almost stripeless, the difference in the coloration of the limbs between the two hybrids is not a matter for surprise.

In connection with the two hybrids born in the Gardens and those that have been bred elsewhere previously between the same species, namely *E. asinus* and *E. zebra*, or *E. quagga*, irrespective of the exact race or breed of the species, the following points may be noticed. The white muzzle of *E. asinus* is eliminated. In other respects asinine characters are dominant over zebrine and quagaine characters, as is shown by the absence of stripes on the mane, the disappearance of the white tip to the ear, and the suppression, partial or complete, of the stripes on the neck, head, body, and quarters. Even when stripes are visible on these areas they do not resemble in width and arrangement those of Mountain Zebras and Quaggas, but are more suggestive of the narrower stripes of Grévy's Zebra (*E. grevyi*), as in the case of some horse-quagga hybrids bred by Prof. Cossar Ewart. Examples of typical *E. asinus* carry a dark basal patch on the ear, a spinal and a shoulder stripe, and very frequently distinct or indistinct bars on the legs. The spinal stripe is also frequent on all Asiatic asses; and the Mongolian species (*E. hemionus hemionus*) sometimes shows traces of a shoulder-stripe and of leg-stripes on the knees and hocks as well. The Tibetan Wild Ass (*E. kiang*) has a large dark basal patch on the ear, and spinal, shoulder and leg stripes are commonly visible in many horses. Although the basal ear-patch, the shoulder stripe, and spinal stripe are absent in typical examples of *E. asinus somaliensis*, no one doubts that this race is descended from asses bearing the marks in question. Intermediate forms indeed, with very narrow spinal and shoulder stripes and a dusky patch on the ear, connect the Somaliland Ass with

ordinary domestic varieties; and in all the many foals born in the Gardens between our Somaliland Ass and domestic asses of English and Spanish breeds, the ear-patch, shoulder and spinal stripes were present as in the dams.

The above stated facts suggest that, with the possible exception of the ear-patch in horses, the shoulder and spinal stripes as well as the stripes on the legs have been lost comparatively recently by the species that are without them.

PAPERS.

45. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received May 23, 1911: Read June 27, 1911.]

(Text-figures 204-215.)

II. ON TWO NEW GENERA OF CESTODES FROM MAMMALS.

The following communication to the Society contains an account of the anatomy of two species of Tapeworms, contained in the collection of Cestoidea belonging to the Society. I feel it necessary to refer them to new genera, and the facts which I shall presently bring forward will I hope justify my so doing. The first of these species is certainly near to *Thysanosoma*, and is, as I think, clearly to be referred to the same genus as a species recently described by me * and temporarily referred to the genus *Thysanosoma*. I pointed out, however, in that paper a number of differences from other tapeworms referred to the genus *Thysanosoma*, and intimated that it probably would be necessary to institute a new genus for the worm. This expression of opinion is justified by the discovery of a second species which is clearly of the same genus. The second species considered in the present paper was placed by me temporarily, and in a report to the Prosectorial Committee, in the genus *Bertiella*. It shows, however, some affinities to *Tenia* (*sensu stricto*) and seems on account of various peculiarities, which in due course will be pointed out, to demand the creation of a separate genus.

I shall commence with an anatomical description of the new species allied to *Thysanosoma*; this I place in a new genus which I propose to call *Thysanotenia*.

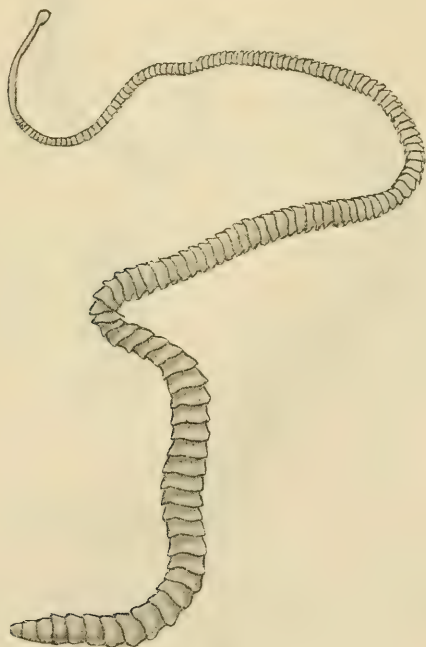
Thysanotenia lemuris, gen. et sp. n.

An example of a Black-headed Lemur (*Lemur macaco*), which had lived in the Gardens three years and three months, contained

* See No. I. of this series, P. Z. S. 1911, p. 651.

two perfect examples, and a number of large fragments, of a tapeworm which I refer to the above new genus and species. There is, as it appears to me, no doubt whatever that these tapeworms belong to the same genus as a species which I have recently described in the "Proceedings"* of this Society as *Thysanosoma gambianum* from the Gambian Pouched Rat (*Cricetomys gambianus*). The external characters are in very near agreement. The present species agrees with *Thysanosoma gambianum* in the unarmed head, in the fact that the segments increase in length posteriorly but are never longer than broad, that the genital apertures are unilateral, and that the eggs are enclosed in a numerous series of paruterine organs in the fully mature segments. This set of characters is sufficient to refer the present species, as well as *Thysanosoma gambianum*, to the subfamily Thysanosominae of the Anoplocephalidae.

Text-fig. 204.



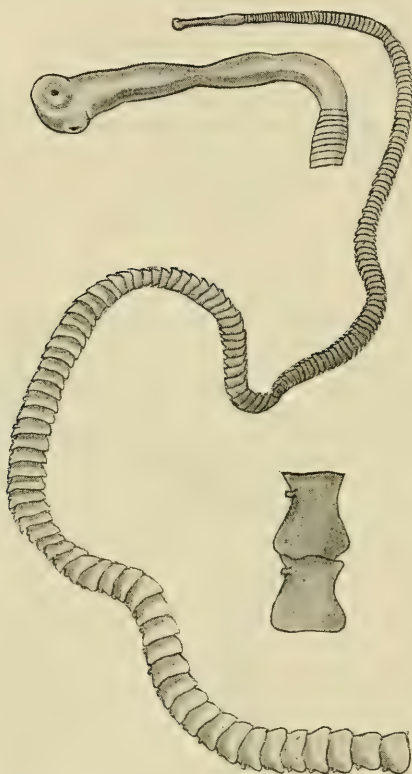
Thysanotenia lemuris, about twice natural size.

Of the two specimens which possessed a scolex, the larger (text-fig. 205) measured at least four inches in length, and was probably longer as it ended abruptly and without a definite terminal

* Above, p. 651.

proglottid, such as was visible in the younger, smaller, example (text-fig. 204). Furthermore, among the fragments was one measuring nearly five inches in length, which may, for what I know to the contrary, have belonged to the first mentioned individual, since it consisted entirely of mature proglottids, which were of greater length individually than the terminal proglottids of the specimen

Text-fig. 205.



Thysanotania lemuris, a second specimen. Above and to the left is the scolex more highly magnified; below and to the right, two segments of another individual showing the papillae which bear the genital pores.

described and figured in this communication. The longest proglottids of the mature fragment were rather more than 3 mm. long, and rather less than 3 cm. wide at the posterior end of the proglottid, which is considerably wider than the anterior end.

The proglottids have no fringes posteriorly such as are present in *Thysanosoma* and provide the reason for the name given.

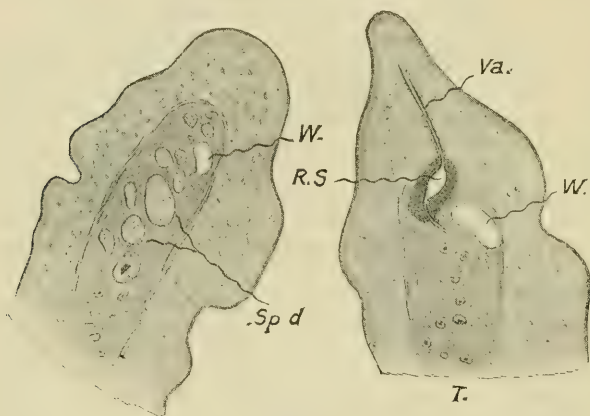
The scolex (text-fig. 205) is of moderate dimensions, not very minute, and quite visible as such by the naked eye. It is more or less spherical, and is marked by some black pigment below the level of the suckers. A pigmentation of the suckers is not uncommon among the Cestoidea, and it seems occasionally to pervade the scolex also. The suckers have a circular orifice, and present no marked features on examination with a lens. They lie some way below the summit of the scolex, and are directed laterally; there is no trace, that I could see, of an upward direction. The smoothly rounded upper end of the scolex shows no hooks. The suckers lie near to the lower end of the head, which is followed by a distinct neck of 2 or 3 mm. in length, in which the strobilisation was not apparent. The strobila are at first much broader than long, and each overlaps its successor at the edges. In the larger specimen, the dimensions of which are given above, the proglottids did not attain to an equality in length and breadth until about three inches or so from the scolex. They never attain to a length which is greatly in excess of their breadth, as will be apparent from the measurements which I have given above. It is noteworthy that in the smaller of the two individuals which are described here, the very few last segments alone showed a length equal to their breadth. In this worm (text-fig. 204) the last proglottid had an oval form, and was of less diameter than those which immediately preceded it. This form is usual for the last proglottid, and serves to emphasize the fact that this specimen was complete and had not begun to cast off proglottids. The ripe proglottids differed from the anterior ones in their greater thickness, and in the fact that their surface was marked by a longitudinal furrowing, caused as I should imagine by unequal distention with embryos. The shape of these proglottids also was different from that of those lying in front, in that they were hourglass-shaped, with, however, as has already been mentioned, a greater diameter posteriorly than anteriorly. The genital pores are unilateral without exception from end to end of the body. They are not at all visible until the segments have begun to increase in length, and are perhaps less obvious upon the very distended posterior proglottids. The pores are particularly obvious in this species, on account of the fact that they are borne upon slender processes of the body-wall, as will be more specially described later in connection with the generative organs. These genital processes lie near to the anterior border of the segments.

If the above account of the external characters of this tapeworm be compared with my account of the external characters of *Thysanotenia gambiana*, it will be seen that the two species, though agreeing in many features, nevertheless show several points of distinction, which enable them to be fully defined as distinct species from these external characters only. It is particularly to be noted that the individual of the two examples of *Thysanotenia lemuris* which I regard as a not fully developed

worm is like the adult *Thysanotenia gambiana* in its characters. Thus the proglottids do not increase at all appreciably in length until the very end of the body, those anterior to this being broader than long. It is, however, clearly a difference between the two species that there are in *Thysanotenia lemuris* a much longer series of proglottids of greater length than diameter, and that the conical projection of the body which bears the generative pore is more pronounced. Furthermore, while the species described in the present communication has a long neck, there is no neck in *Th. gambiana*, the strobilisation commencing immediately after the scolex. Finally, *Th. lemuris* has black pigment in the scolex, which is wanting in *Th. gambiana*. There are thus several obvious differences between the species, which as I think prevent any confusion between them.

In transverse sections (text-figs. 206, 207) it was only possible to see a single *water-vascular tube* on each side. This is of considerable diameter, though it fluctuates in size from place to place

Text-fig. 206.



Thysanotenia lemuris. Two sections across a proglottid, one of which (on the right) shows the genital papilla. The half only of each complete section is shown. *R.S.*, Receptaculum seminis; *Sp.d.*, sperm-duct; *T.*, testes scattered in parenchyma; *Va.*, vagina; *W.*, excretory tube.

and is connected with its fellow in each proglottid by a transverse tube, which lies near to the posterior boundary of the proglottid. The single water-vascular tube of this species appears to represent by its position the innermost of the two tubes found in *Thysanotenia gambiana*. I could find no network of minute tubules arising from these, such as are obvious in the last mentioned species.

Genital organs.—On the whole, the genital system of the species dealt with in the present communication is not very like that of *Thysanotenia gambiana*. There is, however, a very important

point of agreement, in the similarity of the enclosure of the eggs in numerous paruterine organs, which perhaps outweighs the various dissimilarities which will be dealt with in considering the testes and the ovaries and their ducts. The *testes* occupy in *Thysanotenia lemuris* a quite different position in the body from that which they occupy in *Th. gambiana*. They lie in the former species entirely between the water-vascular tubes, and in the medullary region of course of each proglottid. Like the other organs of the genital system, they commence to be visible rather late in the body, thus contrasting very markedly with the conditions obtaining in the second genus described in the present paper. The testes lie mainly in the posterior region of each proglottid, but in front of the transverse water-vascular vessel. They form continuous rows each only one deep, and not, except perhaps here and there, at all crowded. The testes are also extended anteriorly to quite the front end of the proglottid on either side of the ovaries.

The *cirrus sac* is divided, but not sharply, into two regions. The terminal part which encloses the cirrus is narrow, and this tube expands posteriorly into an oval vesicle of much greater dimensions. The whole structure has in fact much the shape of a soda-water bottle. The hinder part of the sac is about on a level with the receptaculum seminis and the sac itself is gorged with sperm, the whole of the available space being filled with a mass of sperm. It is encircled by a thick layer of muscle fibres which run longitudinally to the longer axis of the sac, and form a continuous coat passing in this direction to all round the sac when it is viewed in longitudinal section, that is in transverse sections of the proglottid. At the posterior end the thick muscular layer is interrupted for a minute space, to permit of the entrance of the sperm-duct which narrows greatly at its entrance into the cirrus sac, or rather into that part of the cirrus sac which is specialised as a vesicula seminalis. This narrow region of the vas deferens immediately widens out into a long tract of duct, which may be regarded as a second vesicula seminalis. This tube is wide, quite as wide as in species of *Bertiella*, and is coiled upon itself as it passes back towards the opposite extremity of the body. This region of the sperm-duct would be, if unwrapped from its coiling, of considerable length; I found it to be gorged with sperm. The cirrus itself was generally protruding from the genital aperture. It is not large and has the usual structure of this organ. The difference which it shows from the sperm-duct is very striking, and furnishes an argument in favour of those who would hold that the cirrus is not merely the end of the sperm-duct which is capable of protrusion. It seems in this species at any rate to be a structure independent of the sperm-duct. There is a certain resemblance between the bottle-shaped cirrus sac and the bottle-shaped receptaculum seminis and the end of the vagina. Both of these tubes lie to the same side of the lateral excretory vessels—

if we are to regard the ovary as ventral, they lie to the dorsal side.

The vaginal pore lies behind the opening of the male duct into the genital cloaca. The vagina is a perfectly straight, delicate-walled tube as in so many tapeworms. Posteriorly and close to the lateral water-vessel, the vagina expands into a somewhat pear-shaped receptaculum seminis, from the wider, posterior end of which the vagina emerges again abruptly and runs a curved oblique course towards the ventral side of the body. This latter region of the vagina is of the same calibre and appearance as the terminal section which opens into the genital cloaca. The swollen receptaculum seminis (text-fig. 206, p. 998) has on the other hand thick glandular walls. The ovary and the yolk-gland lie anteriorly in each proglottid and very nearly in the middle of the proglottid, verging however to the pore side, the position being therefore quite different from that which characterises *Thysanotenia gambiana*. The ovary is not large, neither is the yolk-gland.

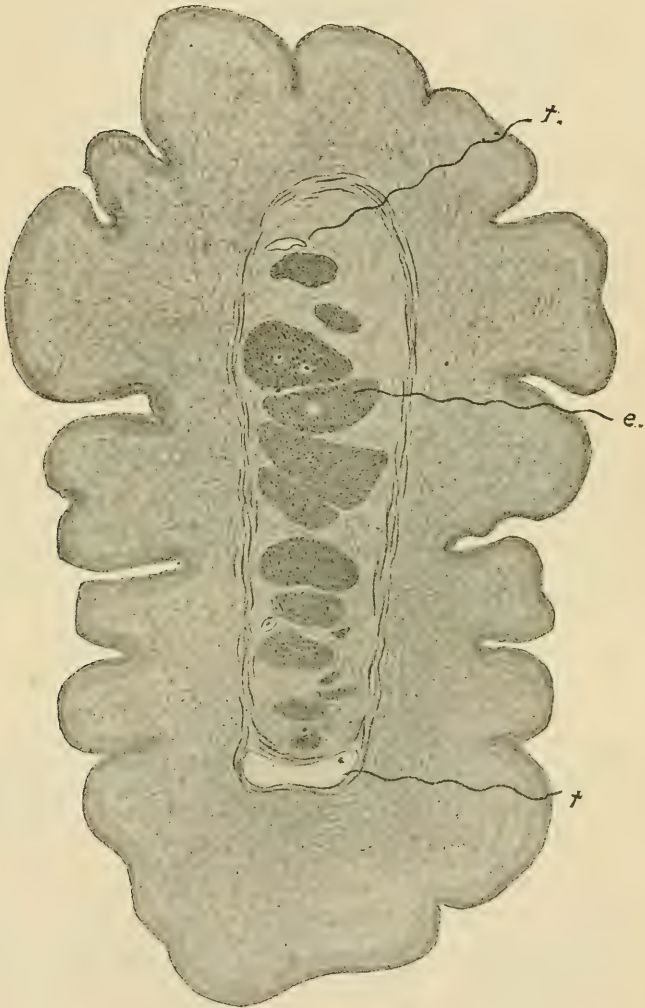
Whether a uterus exists as a definite structure at any period in the development of the sexual organs, I am not able to state with certainty. But I am disposed to think that a distinct uterus does not exist. At the most, it must have a very brief existence, for I can find nothing intermediate between eggs scattered in the parenchyma and in the paruterine organs. I found nothing like what has been described in *Thysanosoma*. In this genus there are stated to be outpocketings of the uterus round each of which is formed a paruterine organ. I found in the present species a condensation of the parenchyma round eggs or groups of eggs, precisely as I have described in *Thysanotenia gambiana*. These latter became more marked, and were then to be described as paruterine organs. In fact, the state of affairs which characterises the genus *Thysanotenia* is to be looked upon as a further stage in the development of such a genus as *Oochoristica* with the intermediate formation of a uterus dropped out, or at least rendered of very little importance. It is also like *Davainea*.

Text-figure 207 represents a transverse section through a fully mature proglottid of this worm. It may be compared with a corresponding illustration of the other species of the genus, *Thysanotenia gambiana**, when certain differences will be apparent coupled naturally with fundamental points of agreement. In both species, the greater part of the medullary region of the segment is occupied by the numerous paruterine organs, which are only one layer deep. They extend between the excretory vessels and up to those vessels on either side. In *Thysanotenia lemuris*, however, the transverse row of paruterine sacs is at most thirteen to sixteen, while they are much more numerous in *Th. gambiana*. Furthermore, in a given section the greater number by far—very often all—of the paruterine organs are seen to be

* P. Z. S. 1911, text-fig. 158, p. 658.

without a contained embryo or embryos. This does not mean, of course, that these are paruterine organs which contain no eggs. It is simply an expression of the fact that in the present

Text-fig. 207.



Thysanotenia lemuris, transverse section through ripe proglottid, showing the longitudinal external furrowing of the proglottid. *e.*, paruterine organs, in only two of which were eggs to be seen in this particular section; *t.*, excretory tubes.

species each paruterus contains fewer eggs (or embryos) than is the case with *Thysanotænia gambiana*. In no case have I seen in a given section more than three embryos within a single paruterine sac in the species which forms the subject of the present communication. In reference to this particular I may compare text-figure 207 with the text-figure of my paper dealing with "*Thysanosoma* " *gambianum* *. The paruterine organs themselves were of about the same size in the two species. The presence of so few embryos in a single paruterine sac produces naturally a very distinctive appearance which at once distinguishes the two species from each other. In each paruterine organ of *Th. lemuris* it was possible to distinguish a cortical and a medullary region of different appearance. That this was not possible in the other species is probably to be accounted for by the large number of embryos which filled them.

It will, I think, be admitted that this tapeworm presents characters which will not fit in with those of any known genus. It contradicts indeed the definitions of families as given by Ransom, at any rate to some extent; for I should be disposed to place the genus in the neighbourhood of *Thysanosoma* in the family Anoplocephalidæ; and yet this family is characterised by the absence of a neck, present in the genus which is now under consideration. The only other position in the series which this worm could occupy, as I think, is in the subfamily Paruterinæ of the family Hymenolepididæ; but in this subfamily the paruterine organs are limited to one or two, and there is nothing like the numerous organs met with in both of the species which I describe here under the generic name of *Thysanotænia*. This latter reason as well as the unilateral genital pores prevent the inclusion of the species in the genus *Stilesia*.

This new genus, *Thysanotænia* †, may be thus defined:—

***Thysanotænia*, gen. nov.**

Moderately large tapeworms, four to six inches in length and three millimetres in breadth. Scolex unarmed, with laterally placed suckers. Proglottids posteriorly as long as or slightly longer than broad. Genital pores unilateral, borne upon a projection of the body near to the anterior end of proglottids. Excretory tubes wide, one or two (and these lying side by side) on each side, with or without ramified branches. Reproductive organs a single set in each segment. Testes numerous, or very numerous. Uterus a narrow transverse sac or absent. Many paruterine organs in ripe segments. Eggs without pyriform apparatus. Adults in Mammals.

* *Loc. cit.* text-fig. 159, p. 659.

† Inasmuch as there are no fringes to the proglottids posteriorly such as occur in *Thysanosoma*, the name selected is rather a misnomer. I have, however, used it more for the purpose of fixing what I consider to be the systematic position of the worm.

Accepting the above as the generic characters of the genus *Thysanotænia*, the two species may be thus defined :—

(1) *Thysanotænia gambiana* F. E. B.

Thysanosoma gambianum Beddard, P. Z. S. 1911, p. 651.

Length about six inches, greatest diameter 6 millimetres. Segments never longer than broad and only a few at the posterior end as long as broad. Genital papilla not very conspicuous. Two excretory tubes on each side, the inner of the two the larger, placed laterally to each other; a network of fine tubules connected with these. Testes in two groups, the larger lying on the side furthest from the genital pore, occupying the space between the two excretory tubes of that side and a little beyond on each side. Ovary and yolk-gland on pore side lying between the two excretory tubes and a little to the inner side also. Sperm-duct narrow or coiled, with a small vesicula seminalis. No receptaculum seminis; vagina opens into a terminal muscular sac. Paruterine organs each with many embryos. Uterus a transverse sac.

Host, Gambian Pouched Rat (*Cricetomys gambianus*).

(2) *Thysanotænia lemuris*, sp. n.

Length four to six inches with diameter of three millimetres. Segments at end of body rather longer than broad. Genital papilla very conspicuous. One excretory tube on each side of body corresponding to the innermost of the two present in *Th. gambiana*. No network of tubules connected with this. Testes scattered through posterior part of the body and anteriorly to the sides of ovary. Ovary and yolk-gland submedian in position, slightly to pore side of segment. Sperm-duct wide and coiled after issuing from cirrus sac. Receptaculum seminis present. Paruterine organs with only three or four embryos in each. A uterus not formed (?).

Host, Black Lemur (*Lemur macaco*).

It is obvious from the above definition and from what has been said in the course of this paper that the two species, which I assign to this new genus *Thysanotænia*, differ from each other in a good many points, and perhaps may be considered to merit generic separation.

Anoplotænia dasyuri, gen. et sp. n.

At about the same time, *i. e.* from February 9th–11th, 1911, three examples of the Tasmanian Devil (*Dasyurus ursinus*) died in the Gardens; only one of them was found to contain tapeworms, and these occurred in that example in very great numbers. The specimens belong, as I believe, to a new species, and I am also disposed to form for it a new genus, which is to some extent allied to the Anoplocephalidæ, but also, in the form of the uterus, suggests *Tenia*, *sensu stricto*. These facts have suggested the

generic name which I here propose. I considered after a rough examination of the worm that it might possibly be referred to the genus *Bertiella*, and suggested this in a report to the Prosectorial Committee; I am now convinced that it cannot be included in that genus and that its characters will not allow of its inclusion in any known genus. The movements of the living worm were particularly active. The worm is not a long form and has a rather unusually large head, as will be gathered from the

Text-fig. 208.



Anoplotænia dasyuri, enlarged about five times.

accompanying figure (text-fig. 208). I could find no trace of any hooks or of any terminal sucker or other structure in the rostellar region. The four suckers are unarmed and of large size.

The scolex is well marked off from the strobila, although there is no obvious neck—that is to say, the segmentation begins apparently at once. This is brought about not only by the

actually large size of the head but by the fact that the first strobila are much narrower than those immediately following, and thus an apparent constriction occurs which emphasizes the distinction of the head. In other cases the conditions are apparently the same; but an examination with a lens shows that though a constriction at about the same distance from the rostellum exists, the formation of strobila exists beyond this point and has invaded the hinder region of the actual scolex. It is a little difficult therefore to assert that a neck is or is not characteristic of *Anoplotœnia dasyuri*. The occasional commencement of strobilisation immediately behind the scolex is not unsuggestive of *Oochoristica**, with which genus the present has some likeness, and there is in the same way a kind of hint of a commencing pseudoscolex.

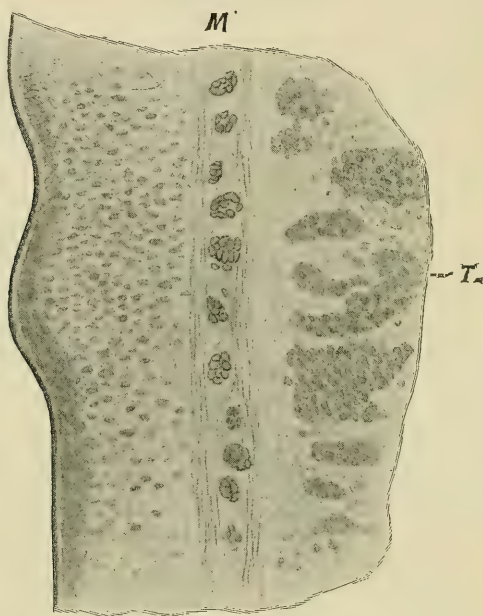
The body of the worm is about an inch in length or sometimes rather longer; but it never grows to a great size. The segments which immediately follow the head are very short; but this region of the body is not long, perhaps a couple of millimetres, and contains but few segments, in some cases not more than a dozen, in others rather more. The segments increase gradually in length and towards the end of the body come to be three or four times as long as they are broad. In the hinder segments the genital pores are sometimes quite obvious when the worm is examined with a lens, and irregularly alternate in position from one side of the body to the other. In transverse sections the body is apt to be hourglass-shaped owing to the greater thickness of the lateral edges of the body due to the bulging caused by the unusually large cirrus sacs. This is certainly the case with the shorter and flatter anterior proglottids.

In transverse sections, through the anterior region of the body in mature segments, which are, however, not long and distended with ova, the layers of the cortex can be readily distinguished. The cortex (text-fig. 209) is of about the same diameter as the medullary portion. It is distinguishable into a much thicker outer layer of longitudinal fibres, and a much thinner inner layer of longitudinal fibres. The two are separated by delicate transversely-running fibres, of which there are also a set within the inner layer of longitudinal fibres and thus bordering upon the medulla. The inner layer of longitudinal fibres is particularly conspicuous for the reason that several are closely grouped into a bundle, of which bundles there is only a single row, as is shown in text-figure 209. This arrangement of the muscular fibres is only apparent in the more anterior segments. It ceases to be obvious in ripe proglottids such as that represented in text-fig. 213 (p. 1012) where the body is gorged with eggs. In these segments however, where, as will be pointed out at length presently, the eggs are partly contained in a uterus and partly scattered singly or in groups through the medullary

* See P. Z. S. 1911, p. 628.

parenchyma, a new set of muscular fibres becomes apparent which I have not observed in the anterior segments and which therefore if really present are not so plain in those segments. The fibres run across the medullary parenchyma in a dorso-ventral direction and apparently belong to the cortical layer of circular fibres. In text-fig. 213 some of these fibres are seen to cross the medullary parenchyma and then to join the longitudinal series of cortical fibres. Possibly these fibres assist in the rupture of the proglottids to expel the eggs, and their presence may also account for the particularly active movements of this species which have been referred to above.

Text-fig. 209.



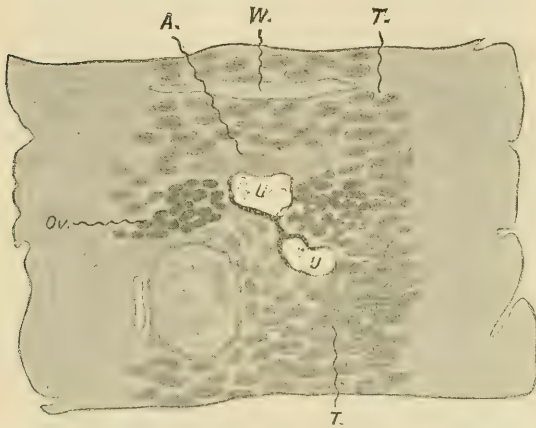
Anoplotania dasyuri, transverse section through part of body-wall. *M*, two delicate layers of circular fibres between which is a special layer of longitudinal fibres grouped into bundles. *T*, testis.

The *excretory vessels* are two on each side and are accurately superposed, *i. e.* dorsal and ventral. Later on in the body only one vessel is very plainly visible on each side, and this is of greater calibre than anteriorly.

The *gonads* and their ducts appear very early in the strobila of *Anoplotania dasyuri*. They commence to be visible within less than 1 mm. of the head immediately after the anterior set of very short segments. The segments, when the ducts are first visible,

are absolutely crammed with apparently mature (certainly very nearly mature) testes. The ducts showed no signs of specialisation. The vas deferens only expanded slightly and gradually into the elongated terminal sac, which is so much specialised in the mature segments to be described later. This immature condition of the ducts persisted for only six segments. Thereafter the cirrus sacs were nearly or quite fully developed. In these anterior segments the ovaries were not so forward in development as the testes.

Text-fig. 210.



Anoplotænia dasyuri, longitudinal section of proglottid. *A.*, shell-gland; *Ov.*, ovary, below which is seen the cirrus sac; *T.*, testes; *U.*, uterus, between which and the cirrus sac are seen the coils of the vas deferens cut transversely; *W.*, transverse excretory tube. The posterior part of the proglottid is above.

The ovaries of *Anoplotænia dasyuri* lie posteriorly in the segment but anteriorly to the vitelline glands, and when fully developed are large and distinctly double. They have the very common bushy form and occupy a good deal of the posterior region of the segment. I did not observe the ovaries to be fully developed until the first segment, in which the cirrus sac is also fully developed and in which the uterus has begun to appear. When the uterus has become so far developed as to fill the greater part of the proglottid, the ovaries quite distinctly lie in continuity with the masses of not fully mature eggs which here fill up the chambers of the uterus.

The vitelline glands are quite evident close to the posterior border of the proglottid; they do not extend out so far laterally as do the ovaries.

The vagina of this worm is, as is so usual in the group, a quite straight tube for the greater part of its extent, that is to say it is not coiled. It lies behind the cirrus sac and opens into the

commencement of the genital cloaca, perforating the muscular pad. Its walls are not distinctly cellular and they stain deeply, both of which features are very common in these animals. Distally, the vagina may be easily followed until it opens into a well-marked receptaculum seminis, which is very large and conspicuous in *Anoplotesnia*. In young segments its course is straight across the segment; in older ones it passes straight to the middle line in an oblique course, then bends back along the middle line of the segment. This sac lies almost exactly in the middle of the body and is absolutely circular in transverse sections of the proglottids. The vagina enters it on the ventral surface and leaves it again at an exactly corresponding point further towards the non-pore side of the proglottid. Thus the tube leaving the receptaculum has to be followed for a short distance in sections before it can be ascertained whether it is the distal or proximal part of the vagina. The receptaculum was gorged with sperm. It is not spherical as might be imagined from its circular contour in section, but narrows to the more slender tube at one end which is beyond the exit of the vagina.

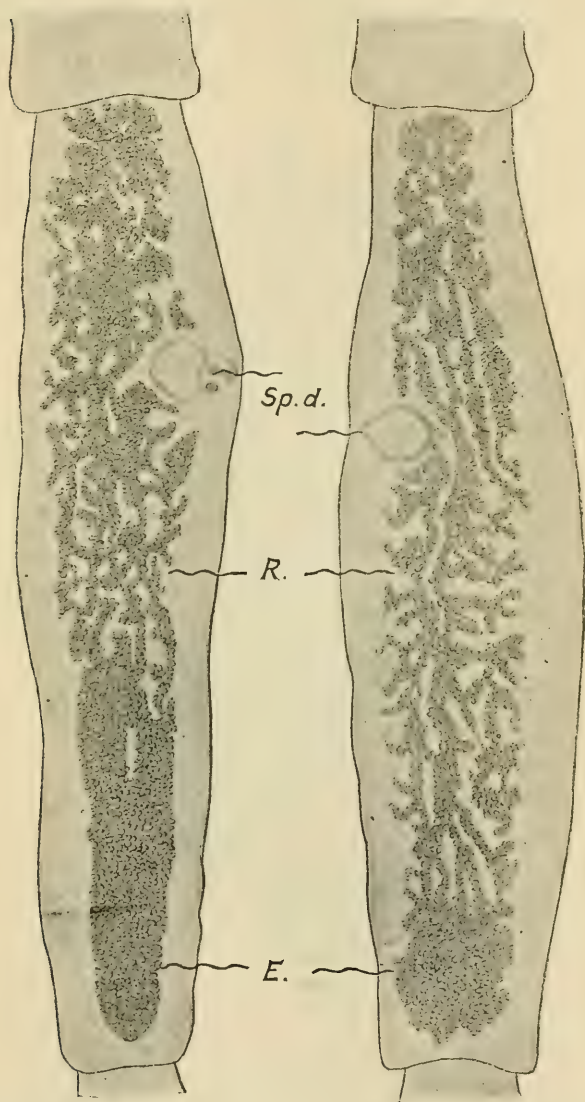
Towards its point of opening into the genital cloaca, the vagina lies parallel to the cirrus sac, in some cases being less oblique in its course than in other proglottids. It has a very thick muscular wall, that is to say thick relatively to the size of its very small lumen. This muscular coat is double, an inner longitudinal and an outer circular layer being present. Opposite the actual point of opening into the genital cloaca, the vagina suddenly widens into a very small sac lying closely adpressed to the muscular pad which forms part of the wall of the genital cloaca; from this sac, a narrow tube passes at right angles to the rest of the vagina and perforates the muscular pad. The terminal sac of the vagina is seen to be filled with sperm. It is related perhaps to the lateral orifice of the cirrus within the invaginated pouch of the cirrus sac: this when protruded forms a bulbous extremity, near to which the orifice would pour its contents into, quite fill and perhaps even somewhat dilate, this terminal sac of the vagina. This matter is, however, more fully dealt with under my description of the cirrus sac and penis (on p. 1014).

I am disposed to think that the receptaculum seminis is no more than a dilatation upon the vagina, for it could easily owe its shape to mere gorging with sperm, and its walls appear to be like those of the rest of the vagina and to have lost their cellular character. It is at any rate greatly disguised in them as in so many other tapeworms. As Gough has lately pointed out,* this non-cellular appearance is preceded by a distinct wall of cells. If the receptaculum seminis be as I suggest merely a local swelling of the vagina, it is clearly quite different in its nature from the receptaculum described above in *Thysanotenia lemuris*. This latter is most obviously a distinct and definitely specialised region

* "Tapeworms of the subfamily *Avitellinae*," Quart. Journ. Micr. Sci. vol. lvi.

of the female tubes. For it is apparent in less mature proglottids and has there walls of a different character from the slender

Text-fig. 211.



Anoplotania dasyuri, two ripe proglottids viewed as transparent objects.
E., masses of eggs at posterior end of proglottid; *R.*, reticular portion of uterus;
Sp.d., cirrus sac.

vagina connected with it. And, moreover, in these younger proglottids its shape cannot be due to any distention by sperm, for the sac was quite empty of sperm. It might be convenient to restrict the term receptaculum seminis for cases of this kind, and not perhaps to name specially the distended region of the vagina in which the sperm is chiefly massed in other forms.

Text-fig. 212.



Anoplotenia dasyuri, transverse section through ripe proglottid.

O., ova; U., cavity of uterus.

The *uterus* of this tapeworm is visible very early in the body in correlation with the early development of the organs of repro-

duction generally. I found, in fact, that the uterus was quite recognisable in the first segment which had a fully developed cirrus pouch, and that segment was one of the earliest to have attained an appreciable length and lay hardly a millimetre behind the scolex. In this segment the uterus showed (in a longitudinal horizontal section through the anterior region of the body) a rounded form stretched in the direction of the transverse section of the body and thus rather oval in outline, and it occupied precisely the median region of the proglottid. In this particular uterus I found no ova. A segment or two further back the uterus is already larger, but it still has the form of a more or less oval sac, extending in these segments towards the pore-side and having thus become eccentric in position. The eccentricity, however, is not very strongly marked. In these segments the uteri were full of ova.

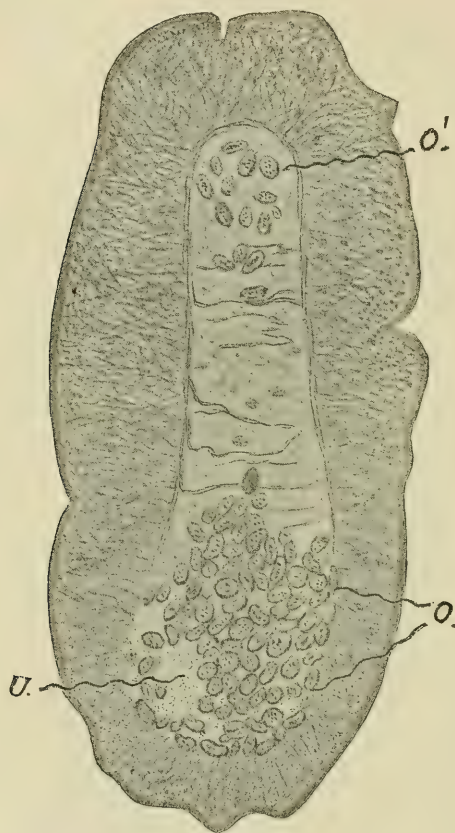
The uterus in these segments lay near to the posterior boundary of the proglottid and was transversely elongated in form; it was distinctly posterior to the strong muscular cirrus sac. The uterus possessed a distinct epithelial wall that was of sufficient thickness to show itself in all my sections (*cf.* text-fig. 210, p. 1007). Later, the epithelial wall is not obvious, but the cavity has plain boundaries and can be recognised as a definite cavity and not merely a system of irregular lacunæ.

In the posterior ripe proglottids the uterus undergoes some changes which are not altogether easy to follow and to correlate. When the elongated, fully ripe proglottids are examined mounted in glycerine, the eggs are seen to be arranged throughout them in a way which differs slightly in different proglottids but is as a rule at any rate on the same plan. The eggs occur in clusters and strings which give the appearance of a retiform uterus. In this, at times, a median string of eggs giving off lateral branches may be recognised. And though these lateral branches join here and there and thus make a network, the general appearance given in such segments is that of the uterus of *Tenia*, which is characterised by a median stem and lateral branches. Very commonly the ova are more thickly clustered together in the posterior region of each segment. There is, I think, little doubt that if the worm were examined only in this way, the uterus would be pronounced to be reticular. A study of sections, however, leads to a rather different interpretation of the arrangements visible in solid preparations. In some transverse sections, such as that illustrated in text-fig. 212, the whole of the interior of the proglottid is occupied by the uterus and the contained masses of developing eggs. These appear to lie in a large undivided cavity, which I take to be the uterus. This region corresponds to the posterior part of the segment, where as already mentioned the eggs tend to become massed.

In other sections through the same proglottid as that which has just been referred to, the conditions observable were different. There are, as is shown in the accompanying figure, eggs and

groups of eggs which correspond to the thinner strings of eggs in proglottids which are viewed as solid objects rendered transparent by glycerine. These groups vary in size, but it would appear that they are imbedded in the parenchyma of the medullary region and are not contained in cavities—that, in fact, there

Text-fig. 213.



Anoplotænia dasyuri, transverse section through ripe proglottid.

O., ova, contained in uterus (U.); O¹, eggs scattered through parenchyma.

is no uterus here at all. It may, of course, have been present and have disappeared. In intermediate proglottids the uterus forms a series of cavities which apparently intercommunicate and thus constitute a network. In these cavities the eggs are not mature—at any rate, the membranes have not yet appeared. This system of cavities fills up a great deal of the available space

and the testes become much restricted and tend to disappear. The most noticeable part of the medullary tissue left is a projection from the region of the cirrus sac lodging the coil of the vas deferens.

It would appear therefore that the uterus in this genus *Anoplotænia* rather combines the characters of that organ in several other genera than presents us with a new type. That it passes through a simple saccular stage is not perhaps a fact of any great moment; for that occurs in many genera. But it is undoubtedly reticular at one time, and, contrary to what is found in such cases, the reticular stage is not permanent.

Text-fig. 214.



Anoplotænia dasyuri, longitudinal section through proglottid, showing the branched and reticular uterus with ova in smaller and larger clumps. *R.S.*, receptaculum seminis; *W.*, excretory tube.

The ultimate condition of the uterus does not fall definitely within any of the types used by Ransom in his table of arrangement of the genera of Tænioid Cestodes; and the condition of this organ in *Anoplotænia dasyuri* is really one of the chief reasons upon which I base its generic distinction from other forms.

The testes of this species are very numerous in those anterior segments in which they are at their full development. They are pressed closely together and overlap and appear to fill all of the available space left between the ovaries and other organs of the proglottid. As the latter are posterior in the segment, the testes are mainly anterior. Both in longitudinal and sagittal segments the testes can be seen to be limited in their occurrence only by

the cortex. In correlation with their large numbers, the testes are of small size. They cannot, obviously, be said to be either dorsal or ventral or anterior or posterior in position.

A good deal of the anterior part of each mature proglottid is occupied by a large coil of the *vas deferens* which forms a larger mass than in many tapeworms figured or known to me at first hand. Although this coil lies anteriorly in the segment on a level with the large cirrus sac, it does not touch the anterior boundary of the segment. In front of it there is to be seen a considerable heap of testes. The coil is generally in close contact with the cirrus sac. I found no vesicula seminalis in this species, but the coiled tube gets wider when ripe.

The *cirrus sac* and its contained structures are rather remarkable in this species and much more complicated than in many other species, including the three that I have already described in my former communication*. As already stated, the organs of reproduction appear very early in the chain of proglottids. It is, however, not for some segments that the cirrus sac is fully developed. The fully developed cirrus sac coincides with the first appearance of the uterus. As already mentioned, in considering the external characters of this worm, the cirrus sac when mature is so large as to cause an appreciable bulge in the segment. It therefore entirely fills the medullary region of that part of the segment where it occurs, as seen in a transverse section. In such sections it may also be seen that the cirrus sac and the genital cloaca together (of which a description follows) occupy about one-third of the entire breadth of a proglottid.

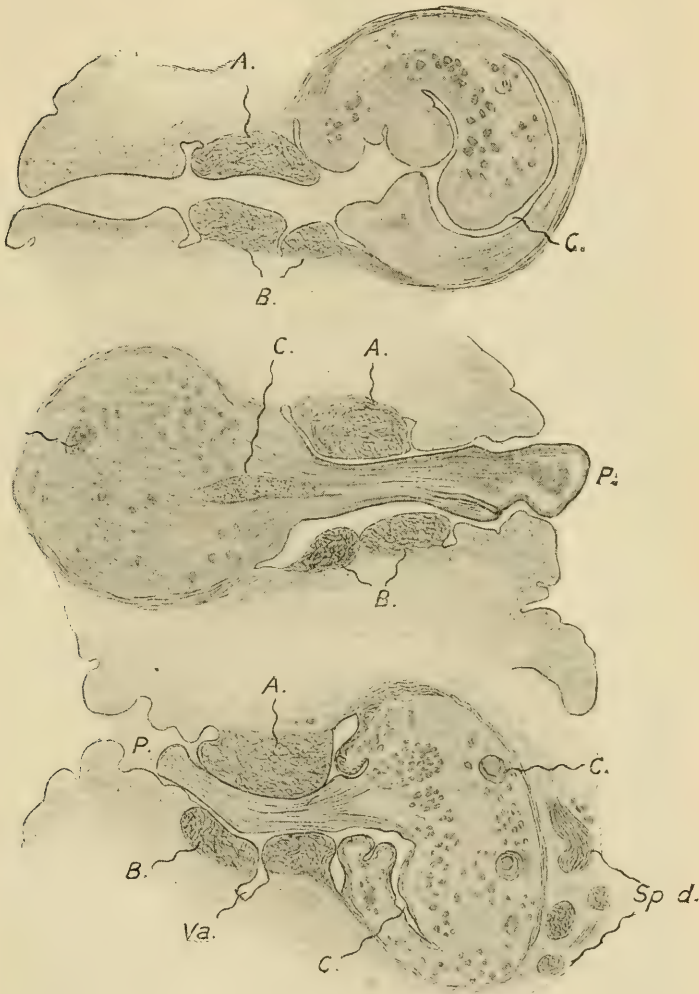
The cirrus sac is nearly if not quite spherical in shape, and consists of an outer coat and of an inner mass of tissue. The outer coat is not very thick and is muscular, the fibres no doubt serving to compress the sac and thus bring about the evagination of the cirrus. The internal tissue of the cirrus sac is a tissue in which the cirrus itself is embedded, and it entirely fills the sac save where it is traversed by the cirrus. It contains many nuclei scattered fairly closely throughout it, and delicate fibres which may be occasionally seen to possess a distinctly retiform arrangement. It seems to me to be a soft tissue which is an elastic packing material transmitting to the cirrus the contractions of the external muscular coat of the cirrus sac. In some sections indeed the nuclei can be seen to be more compressed and regularly arranged in lines in the immediate neighbourhood of the eversible cirrus sac. This might seem to argue some contractility possessed by the tissue forming the core of the cirrus sac.

The cirrus itself is peculiar and complicated in structure. It consists of two parts. First of all there is the part which lies immediately within the cirrus sac and which is perfectly continuous with the vas deferens, and shows no sudden differences

* P. Z. S. 1911, p. 626.

of structure that I can detect from the vas deferens. It lies in a loose coil of only two or three turns. Followed distally, this tube

Text-fig. 215.



Anoplotenia dasyuri. Cirrus sac with penis in various stages of retraction.

In the upper figure the penis is completely retracted, in the middle figure it is completely protruded; in the lower figure it is incompletely protruded. *A.*, muscular pad on anterior side of genital cloaca; *B.*, muscular pad on posterior side of genital cloaca which is perforated by opening of vagina (*Va.*); *C.*, cirrus; *P.*, penis, on the posterior side of which, as is shown in the middle figure, the cirrus opens; *Sp. d.*, vas deferens.

is seen to open into an invaginated sac which lies pushed into the solid core of the cirrus sac, as is shown in the text-figure accompanying this description. This sac is irregular in form with crumpled walls, and it is surrounded by a layer of particularly stout muscular fibres, which lie therefore within the cirrus sac and form a differentiated portion of its core. These muscular fibres lie loosely round the invaginated sac. The wall of the latter is rather thickened to form a pad lying on the anterior side, and close to this the cirrus opens into it, their cavities becoming continuous. The opening into the sac is opposite to the pad, and therefore on the posterior side of the sac.

The cirrus sac does not open directly on to the exterior, but through a genital cloaca which is itself much complicated. A horizontal section through the whole structure is represented in text-fig. 215. The genital cloaca may be divided into three or four regions; the invaginated penis (as we may term the in- and evaginable sac into which the cirrus opens) is continuous with a wide but narrow cavity of quite as great a diameter (antero-posterior) as the cirrus sac itself, but very narrow from side to side. After this comes a tubular cavity surrounded by a very thick layer of circular fibres which are perforated, as already mentioned, on the posterior side by the vagina which here enters the genital cloaca. In horizontal sections such as that represented in text-fig. 215, this layer of muscles appears as two strong muscular pads, that on the posterior side being longer from side to side than the one opposite. After this the canal widens a little for the terminal part of its course and its walls are rather crumpled, there being a particularly deep recess immediately after the sphincter region which precedes it. A considerable portion of the cirrus sac can be evaginated, sometimes more and sometimes less. These differences also are shown in text-figure 215. In some cases only the anterior side of the cirrus sac is protruded, which in such a case barely reaches the external orifice of the genital canal. In other cases much more is protruded, and the cirrus itself is drawn down into this penial protrusion which extends well beyond the external orifice. In this latter case, however, which represents the extreme of what I have seen in my sections, the actual opening of the vas deferens is not at the tip of the protruded penis, but at the side and within the genital canal. I may not perhaps have seen instances of extreme protrusion. It is noteworthy that the orifice of the vas deferens is on the posterior side of the penis and thus corresponds to the vaginal orifice. Possibly a complete extrusion of the penis takes place in cases of cross-fertilisation.

The following are the general characters of this species * :—

Head quite unarmed, of rather large size and with four unarmed suckers. Strobilisation begins at once, there being no "neck"; the first two or three strobila wider than those which immediately follow

* I do not attempt to discriminate between generic and specific characters.

and of same diameter as or wider than head, thus forming a rudimentary pseudoscolex. The proglottids increase very rapidly to a considerable length, the posterior being longer than broad and becoming detached. Not more than ten or a dozen anterior short proglottids. Genital orifices single and irregularly alternate. Excretory tubes posteriorly one on each side of body, that of one side being as a rule wider than that of opposite side; in anterior segments two on each side. Testes very numerous, filling up the whole space left by other organs in proglottid. Vas deferens coiled. Cirrus sac very large and spherical and somewhat peculiar in structure, with an eversible sac reaching the exterior through a much differentiated genital cloaca. Ovaries posterior in segment and with vitelline glands posterior to these. Vagina straight and narrow, opening posteriorly to cirrus sac; a receptaculum seminis present. Uterus at first a simple sac, later a reticulum, and later still part of the uterus remains, while other eggs are imbedded singly or in groups in the medullary parenchyma. Eggs without V-shaped apparatus.

It will be, as I think, evident from the résumé of the characters of this species just given, that it cannot be referred with any confidence to any one of the really known genera of the Tetracoylea. The convenient table giving a key to the various genera used by Ransom in his memoir enables one to refer the species from *Dasyurus ursinus* to the neighbourhood of *Oochoristica*, *Tenia* (s.s.) or *Bertiella*. Of the latter genus several species are known from Marsupials; but they are not known from the present genus, and appear to be nearly limited to the herbivorous (at any rate Diprotodont) genera, i. e. *Phalanger*, *Phalangista*, and *Phascolarctos*.*

These species, however, are certainly not congeneric with that which I describe in the present paper. They agree with the generic definition given by Ransom†, who doubtless took them, as well as the species of *Bertiella* from Apes and Rodents and Birds, into consideration when formulating his definition. The worms studied by myself show the following important differences from *Bertiella* as defined by Ransom:—The strobilisation is different, the posterior strobila being much longer than broad; the genital canals pass between the dorsal and ventral excretory vessels; the testes exist throughout the segment save where space is occupied by the ovaries etc.; the uterus is of a totally different character; the cirrus sac is also totally different from anything figured in *Bertiella*. I do not feel able therefore to refer this species from *Dasyurus ursinus* to the genus *Bertiella*.

I am of opinion that the present genus is nearer to the genus *Oochoristica*. The latter genus actually occurs in carnivorous Marsupials but in Neotropical forms, in fact in *Didelphys*, and not, however, so far as I am aware, in Australian Marsupials. The

* See Zschokke in Semon's 'Reise,' Jena 1898, for *B. obesa* and *B. semoni*; and the same author, "Neue Studien an Cestoden aplacentaler Säugethiere," Zeitschr. wiss. Zool. lxx. 1899, for *B. edulis* and *B. sarasinorum*. Also Janicki, "Die Cestoden Neu Guinea's" in Nova Guinea, Livr. v., 1906, p. 281, for *B. rigida*.

† Loc. cit. p. 62.

general form of the body and the segmentation is not unlike in the two genera; and especially to be noted is a resemblance in the scolex. In the present genus as in the *Oochoristica* from *Tamandua tetradactyla*, described by myself* some months since, the strobila, as it were, invade the scolex. On the other hand, the early disappearance of the uterus and the imbedding of the ova singly in the medullary parenchyma is a character of *Oochoristica* which distinguishes it from the genus which I propose to call *Anoplotaenia*. The peculiar cirrus sac and the very complex genital cloaca are points in which *Anoplotaenia* differs from all the genera with which I here compare it.

There now remains the genus *Taenia* (*sensu stricto*) to which the present species shows a certain amount of likeness in the uterus, which is rather pronounced in certain proglottids. There is in fact occasionally a quite distinct median stem with branches. *Taenia*, however, has an armed rostellum which is sometimes not armed as in *T. (Taeniarhynchus) saginata*, where the hooks drop out early and are replaced by a sucker-like structure†. There is nothing of this kind in the present species, which moreover bears no such close likeness to *Taenia saginata* as would warrant its inclusion in the same genus or subgenus. Another genus in which the uterus has a marked median stem and lateral branches is *Catenotaenia*,‡ the species of which occur in the mouse and in the squirrel. In this genus, however, the testes and ovaries have a different position from that which is met with in the tapeworm dealt with in the present memoir, and the relation of the genital duct to the excretory tubes is also different.

46. Some Madreporaria from the Persian Gulf. By RUTH HARRISON, Oxford §. With a Note on the Memoir and some Further Notes on *Pyrophyllia inflata* by SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., F.Z.S.

[Received May 19, 1911: Read June 27, 1911.]

(Plates LVII. & LVIII. || and Text-figures 216-221).

This collection of Madreporarian corals was made by Mr. F. W. Townsend, and entrusted to me for identification and description by Professor Hickson. I should like to take this opportunity of thanking Professor Hickson for putting this interesting piece of work in my hands. My thanks are also due to Professor Bourne for allowing me to carry on the work in his laboratory and placing all its resources at my disposal, and for help and advice during the

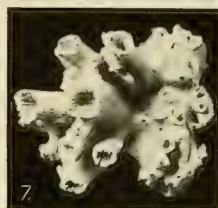
* P. Z. S. 1911, p. 627. I ought to have mentioned in that paper that something of the same kind appears to occur in *O. rostellata* (see Zschokke, Zeitschr. wiss. Zool. vol. lxxxiii. 1905).

† Cf. Bronn's "Thierreich," Vol. iv. Abth. B. p. 1720.

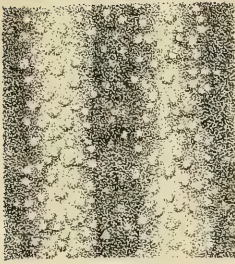
‡ Janicki, Zeitschr. wiss. Zool. 1906, vol. lxxxi. p. 505.

§ Communicated by Prof. S. J. HICKSON, F.R.S., F.Z.S.

|| For explanation of the Plates see p. 1044.



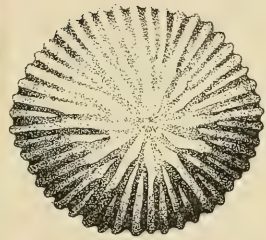
MADREPORARIA FROM THE PERSIAN GULF.



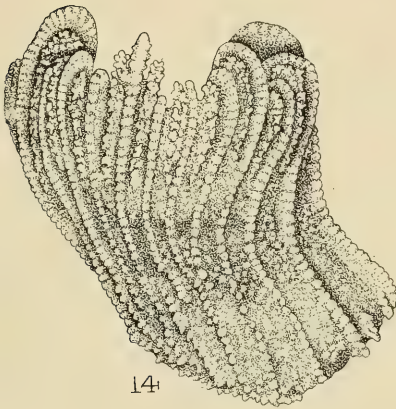
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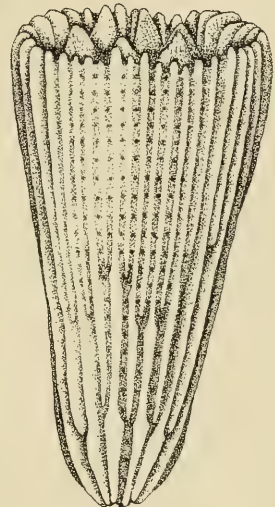
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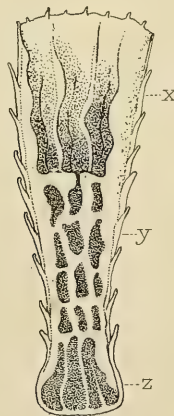
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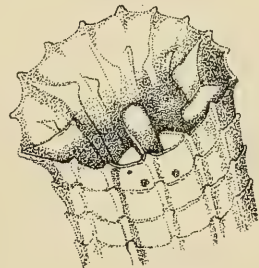
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18

MADREPORARIA FROM THE PERSIAN GULF.

progress of the work; to Professor Sollas for permission to use his apparatus, which enabled me to grind sections, photograph and reconstruct a wax model of *Trematotrochus zelandiae*; to Professor Jeffrey Bell for permission to examine various Madreporaria in the British Museum; and to Professor Stanley Gardiner for the loan of a large number of his specimens of *Heterocyathus aequicostatus* for comparison with the present collection.

The collection consists of examples of the following species:—

Family GUYNIDÆ.

Pyrophyllia inflata Hickson [25].

Family FLABELLIDÆ.

Flabellum magnificum v. Marenzeller [28].

Family TURBINOLIDÆ.

Heterocyathus aequicostatus Milne-Edwards & Haime [29].

Heterocyathus heterocostatus, sp. n.

Paracyathus cavatus Alcock [1].

Trematotrochus zelandiae Duncan [14].

Agelecyathus persicus Duncan [14].

Family FUNGIIDÆ.

Fungia patella Milne-Edwards & Haime [29].

Family EUPSAMMIIDÆ.

Heteropsammia aphrodes Alcock [1].

Dendrophyllia sp.?

All these specimens are in the Manchester Museum. The occurrence of a recent *Trematotrochus* is worthy of special attention. Hitherto, the genus has been known from seven fossil and one recent species from Australia and Australasian seas, and it is remarkable to find it appearing in so remote a locality as the Persian Gulf. More remarkable still is the fact that this very species has already been described from Cook's Strait, New Zealand, by Professor Martin Duncan under the name of *Conocyathus zelandiae*. The resemblance of the coral I have been examining to the figures and description (so far as it went) of this *Conocyathus* was so striking, that it occurred to me that possibly Duncan had overlooked the perforations of the wall, characteristic of a *Trematotrochus*. Owing to the kindness of Professor Jeffrey Bell I have been able to re-examine the original type specimens in the British Museum, and the result of this examination has been to convince me that the corals are absolutely identical. The British Museum species have not been so carefully cleaned and dried as those in the present collection, and in places the intercostal furrows are somewhat choked up by sand and grit; but that perforations do exist, exactly similar to those of the Persian Gulf species, I have no hesitation in stating; in parts of the corallum they are clearly visible, but unless one were

expecting to find them it would be very easy to overlook them, and it is not altogether surprising that Duncan should have done so. Had he observed them, I venture to think he would not have called the coral a *Conocyathus*. In his 'Revision of Families and Genera' he places *Conocyathus*, *Trematotrochus*, and *Turbinolia* together as closely allied forms; indeed the perforations of the theca of *Trematotrochus* form the only feature which separates it from *Conocyathus*. Now that perforations have been observed in *Conocyathus zelandiae*, we must either amend the definition of that genus, or else remove this species to the genus *Trematotrochus*. The existence of pores is a character of such importance that the latter course seems to me advisable, and in future *Conocyathus zelandiae* should be known as *Trematotrochus zelandiae*. The specific name is unfortunate and apt to be misleading, as is bound to be the case when a specimen is given a name denoting the locality in which it was originally found, and subsequently appears in other parts of the world. A further consideration of the structure and systematic position of this coral will be found in the systematic part of this paper.

Family GUYNIDÆ.

PYROPHYLLIA INFLATA Hickson [25]. (Pl. LVII. figs. 8-11; Pl. LVIII. figs. 18, 19.)

About sixty specimens of this species were obtained on a gravelly bottom at a depth of 156 fathoms in the Gulf of Oman. Professor Hickson has added some further notes to his original description of this species at the end of this memoir (p. 1039).

FLABELLUM MAGNIFICUM v. Marenzeller [28.] (Pl. LVII. figs. 1-3.)

Corallum fan-shaped, wall and septa very thin and delicate. Numerous rootlets descend vertically downwards, each such rootlet communicating with two interseptal chambers on opposite sides of a septum, and firmly fixed on a mass of mud and serpulid tubes. Calice oval in outline, but constricted in the middle of the short diameter; practically semi-circular at the ends of the long axis. Two specimens, measuring as follows:—

	I.	II.
Height	30 mm.	15 mm.
Calice { Long diameter	60 "	40 "
{ Short diameters		
{ Greatest width	40 "	26 "
{ Least width	30 "	25 "
Number of septa	175	96
" " primary septa	24	24

Costæ faintly indicated throughout entire height of the corallum which is also marked with fine wavy transverse accretion lines. Septa in six systems of six cycles of which the sixth cycle is incomplete, while there are present a few rudimentary septa of a seventh cycle. Those of the first three cycles equal and reaching the columella, edges vertical, entire until within about 4 mm. of the columella where a few coarse denticulations may be present; beset with minute blunt spines arranged in transverse and radial rows. Septa of lower cycles become successively smaller. Columella parietal, only slightly developed.

Locality. Telegraph Cable, Persian Gulf. Depth not recorded.

In the larger specimen there are 175 septa arranged as follows *:—

	Number of septa.	Number of septa of 6th cycle wanting.	Number of supernumerary septa of 7th cycle.
Chamber 1	31	3	2
„ 2	25	7	none
„ 3	30	2	none
„ 4	26	6	none
„ 5	30	2	none
„ 6	33	5	6
Total	175	25	8

This coral differs from v. Marenzeller's species in its smaller size and the presence of numerous rootlets. Gardiner [19] has shown that the presence or absence of such rootlets is a variable character, and he has described rootlets in *Flabellum rubrum*, a species in which they had not previously been recognized.

v. Marenzeller's species was made for a single specimen, and as the agreement between the calicular and septal characters of the specimens under consideration and those of the type are so similar, it has been considered advisable not to separate them.

Family TURBINOLIIDÆ.

Genus HETEROCYATHUS.

The genus *Heterocyathus* has been critically examined by Gardiner [20], who had at his disposal a very large number of specimens. He absorbed the species of Semper and Rehberg in a single variable species originally described by Milne-

* The septa are considered as being divided into six chambers, bounded by primary septa; the chambers are considered in rotation beginning with one to the right-hand side of a directive septum.

Edwards & Haime [23] as *Heterocyathus aequicostatus*; to this Bourne [6] has since added *Stephanoseris rousseaui*.

In the large collection of corals from S. Africa, Gardiner recognized two types with the following diagnostic characters:—

TYPE I. Costæ equal in size, rounded and covered with low granules (Pl. LVIII. fig. 12), small intercostal spaces; base smooth, low granules, only traces of costæ; theca with thin upper edge, never more than 1 mm. above columella; septa in four cycles, thick with narrow interseptal spaces, average exsertness 1.5 mm.; cycle i. broader and more exsert than cycle ii., ii. than iii., iv. more exsert than iii., higher on either side of i. than of ii. Sides set with low ridges, edges not toothed; commonly certain ones, or all, coloured black; pali before all cycles, large and conspicuous; columella a mass of rods decreasing in size and height from the pali towards the centre of the axial fossa, densely packed together.

TYPE II. Costæ of cycles i., ii., and iii. larger than iv., which consists of a row of separate granules rougher and higher than in Type I, with broader intercostal spaces (Pl. LVIII. fig. 13); base roughly granular, costæ sometimes extending on to it; theca with thin upper edge, generally 2 to 3 mm. above the top of the columella; septa in four cycles with a tendency to have some of a fifth cycle represented, thin with broad interseptal spaces, average exsertness 3 mm.; ridges on sides conspicuous, edges toothed towards centre of calice; all the same colour, white or some shade of grey; no proper pali or columella; septa iv. fuse with septa iii., and these again with ii.; septa i. generally separate, but in the centre fuse with the rest forming a mass of trabeculæ covered by fine points which run up along the septa of cycles i. to iii. for some distance, almost like fine teeth.

In describing the collection of Mr. J. J. Simpson and Dr. Rudmose-Brown from Burma, Miss Poole [24] recognized the Gardiner's two types, and added a third type with a fifth cycle of septa, four crowns of nodular pali, and a deeper fossa.

I have been able to re-examine the collections described by Professor Gardiner and Miss Poole, and, so far as the former collection is concerned, the two types are sufficiently different, in my opinion, to be regarded as two species. Gardiner himself has described them as "two perfectly distinct modes of growth, almost two varieties." I have searched in vain for intermediates, and although I had no difficulty in picking out the two specimens which the author describes as doubtful, they are both too much broken and corroded to afford any clear evidence that they represent a form intermediate between the two types. The general facies are entirely different. In Type I, the tendency is for the base to be broader than the calice in correlation with rounded granular costæ, thick septa, practically no fossa, and a papilliform well-developed columella. In Type II, the tendency is for the coral to taper away to a point from a circular calice; such is the form of the only known example without a commensal

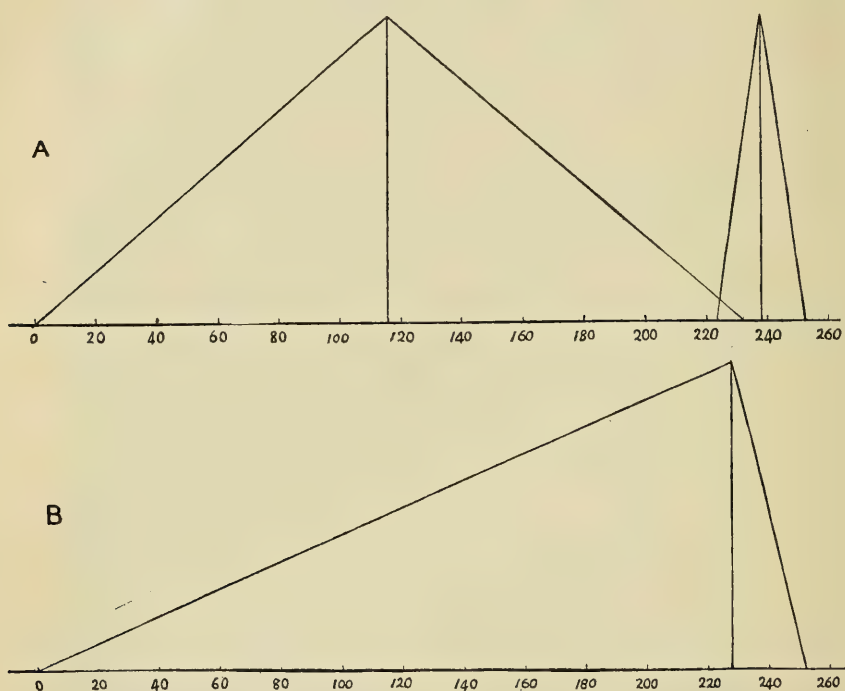
Aspidosiphon; the flat base of the normal specimen is never so large as the calice, and this shape is invariably in correlation with alternating costæ, thin septa, a deep fossa, and an ill-defined columnella.

The characters of the costæ of the two types are very definite. Fig. 12 on Plate LVIII. represents two adjacent costæ of Type I, low broad ridges, covered all over with fine uniform granules; the intercostal furrows are small and shallow. Fig. 13 on Plate LVIII. represents two adjacent costæ of Type II: on the right is the type of costa which corresponds to septal cycles i., ii., and iii., a prominent exsert ridge, on which the granulations tend to become regular transverse bars; on the left is a costa corresponding to septal cycle iv., slightly less exsert, and beset with very irregular coarse granulations; the intercostal furrows are deep. These marked differences, always in correlation with the differences of the calicular characters to which reference has already been made, are too consistent to retain both forms in the same species. True, there are many examples of Type I which have an alternation of broad and narrow costæ, but such costæ are always alike in being low and uniformly granular; the alternation of coarsely granular costæ and much exsert narrow costæ is never discernible. In some, however, there is a tendency for the costæ of Type I to become more exsert and more coarsely granular at the calicular margin, but this generally occurs where the whole growth of the coral has been distorted by being fixed to an abnormally large shell, and it might be thought that this distortion had influenced the form of growth. Indeed, it suggested the possibility that the shell on which the coral fixes itself, and the position which that shell assumes within the actual body of the coral, might influence the mode of growth to such an extent that not only the general shape but the character of the septa and costæ might be controlled. This, however, is not the case. There are well-defined examples of Types I and II both fixed on exactly similar shells: in some the *Aspidosiphon* in corals of both types is coiled horizontally forming a flat base, in others the corals are fixed to shells which lie sometimes horizontally, sometimes vertically within the coral zoophyte, and there are always examples of both types harbouring *Aspidosiphons* in shells which assume either position; so that the species of shell or the position it assumes exercises no influence on the manner of growth of these two well-defined types. Such types vary about two distinct modes, with a slight overlapping of the extremes of variation; and are not themselves the extremes of a single growth mode. The relation of the species to each other is represented in text-fig. 216.

Of some 252 individuals in the South African collection, there are 225 of Type I and 19 of Type II, and 8 which have characters common to both types. The characters which separate the two types cannot be measured and given numerical values; consequently in text-fig. 216 A the point about which the two growth-modes

vary is purely arbitrary, but the number of individuals which vary about these points is a real number, and represents the two distinct growth-modes of two different species. If the two types were varieties of a single growth-mode, the variation might be expressed by such a diagram as text-fig. 216 B, but that would represent a condition of affairs wholly contrary to the numerical facts; for the intermediates, which in reality are less than a thirtieth of the whole number, here represent the greater number of forms.

Text-fig. 216.



A.—A diagrammatic representation of two species which vary about two distinct modes, the extremes of which converge towards one another. The abscissæ give numbers which vary about each mode respectively.

B.—A diagrammatic representation of a single species varying about an imaginary mode.

Type I is undoubtedly the *H. æquicostatus* of Milne-Edwards & Haime, although, as I shall show, there are considerable variations within the type. Type II is probably identical with Verrill's [42] *H. alternatus*, a species which has escaped the notice of several authors. This species possesses all the characters which separate Gardiner's Type II from Type I,—the base smaller than the disk, with a slight constriction above it, and then walls spreading obliquely outwards to the edge of the disk,

alternating costæ, paliform teeth exsert before all septal cycles except the last, and an ill-developed papillose columella which scarcely rises above the surface of the broad shallow central fossa.

When Miss Poole stated that the forms in the Burmese collection belonged to three different Types, two of which were identical with Gardiner's Types I and II, she had not the advantage of seeing the actual specimens, and was in error. All the Burmese forms belong to Gardiner's type I, but they show great variation, and in order to justify their inclusion with *H. aequicostatus* three types must be recognized. These types may be called A, B and C to avoid confusion, but it must be understood that they correspond with Miss Poole's Types I, II & III.

Type A=Type I as defined by Gardiner. There is normally a single small aperture on the basal surface in addition to the opening of the *Aspidosiphon* chamber. In a few, this additional aperture is absent, whilst in others, two or at most three such apertures occur.

Type B is a much lower flattened form without a fossa; a tendency for the costæ to alternate; four septal cycles, the exsertness of the septa of the fourth cycle on either side of the primaries is very marked, and the joining over the tertiaries and secondaries gives a characteristic star-like appearance; the columella is less well-developed, it is a compact trabecular mass, and not distinctly papilliform as in Type A; the pores of the endodermal canals are more numerous, and are not restricted to the base, but are distributed irregularly round the lower part of the corallum.

Type C is a taller form, the base tends to equal the disk in diameter, and the walls are nearly perpendicular; a fifth cycle of the septa is present; there is a distinct fossa, and the centrally depressed columella is a trabeculate mass as in the previous type; the pores of the endodermal canals are disposed in a ring a little below the calicular margin.

In defining these three types, I have retained Gardiner's Type I and Miss Poole's Type C in order to avoid confusion as far as possible; but it must be borne in mind that Type B as here defined is very different from Gardiner's Type II.

Practically the whole of the South African collection belongs to Type A, the Burmese collection belongs to Types B and C; the specimens Miss Poole described as belonging to Type I should be included in Type B. The Ceylon collection described by Professor Bourne is somewhat intermediate between Types A and B. These three types will embrace the species of Semper, Rehberg, and Alcock*.

H. parasiticus Semper [38]. Intermediate between Types A and B.

H. philippinensis Semper [38]. Two types. Pl. xx. fig. 12 is Type B. Pl. xx. figs. 13 & 14, Type C.

* I have not considered *H. sulcatus* and *H. lamellosus* Verrill, and *H. cochlea* Gmelin, as I have not been able to obtain first-hand reference to these species.

- H. pulchellus* Rehberg [37]. Intermediate between Types B and C. General facies, fifth septal cycle and depressed columella, Type C. Alternating costæ and distribution of lateral pores, Type B.
- H. oblongatus* Rehberg [37]. Type C.
- H. wood-masoni* Alcock [1]. Type B.

The specimen from the Persian Gulf also belongs to Type B.

The other specimens of *Heterocyathus* in the Persian Gulf collection constitute a new species. The tendency to remain conical is very marked; the costæ are distinct from those of other species; and the uniformity in size separate it sufficiently until a good series of intermediates are found which will link it up with *H. alternatus*.

I therefore recognize in the genus the following species:—

1. *H. æquicostatus* Milne-Edwards & Haime.
Stephanoseris rousseaui Milne-Edwards & Haime.
H. parasiticus Semper.
H. philippinensis Semper.
H. oblongatus Rehberg.
H. pulchellus Rehberg.
H. wood-masoni Alcock.
2. *H. alternatus* Verrill.
H. æquicostatus (Gardiner's Type II).
3. *H. heterocostatus*, sp. n.

HETEROCYATHUS ÆQUICOSTATUS Milne-Edwards & Haime [29].

A single specimen belonging to Type B. Costæ, equal in number to septa, extend to base, beset with irregular spines. Base roughly granular. Slight calicular fossa. Septa in six systems of four complete cycles, very spiny; those of the fourth cycle fuse with those of the third, and these in turn fuse with those of the second. Inner margins of septa pass imperceptibly into the trabecular columella.

Locality. Telegraph Cable, Persian Gulf. Depth 40 fathoms

HETEROCYATHUS HETEROCOSTATUS, sp. n. (Pl. LVII. fig. 6; Pl. LVIII. fig. 14.)

Corallum simple, free, variable in shape from a low discoid form to a conical cornuate form. Upper part of corallum deeper in colour than base. Height varies between 3 mm. and 7 mm., and calice between 3.5×3 mm. and 6×5 mm. Costæ of two distinct types. Those corresponding to the septa of the first, second and third cycles are visible from the base to the tip of the calice, prominent sharp ridges with a single series of coarse granulations; the alternate costæ, corresponding to the septa of the fourth cycle, extend only about half-way down the corallite from the lip of the calice; they are less prominent, and beset with numerous irregular granulations. Calice slightly elliptical,

open, deep. Septa in four complete cycles. Primaries large, very prominently exsert; quaternaries join over the tertiaries, and again deep down in the calice over the secondaries; quaternaries on either side of the primaries much developed, and prominently exsert in the manner typical of the genus *Heterocyathus*; all septa beset with numerous fine granulations arranged in radial ridges. Pali in the form of small denticulations, which pass imperceptibly into a parietal, fasciculate, centrally depressed columella. At the base, a circular aperture leads to an *Aspidosiphon* chamber containing a small Gastropod shell, in which a Sipunculid lives commensally with the coral zoophyte.

Nine specimens.

Locality. Karachi. Depth 15–40 fms.; bottom, shell-sand.

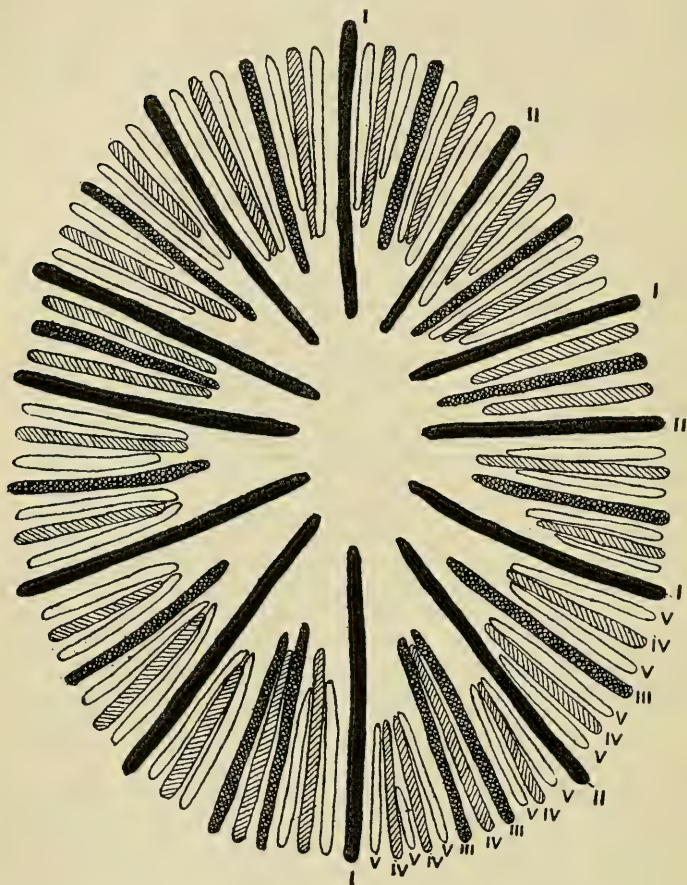
PARACYATHUS CAVATUS Alcock [1]. (Pl. LVII. fig. 5.)

Corallum simple, fixed by spreading base and expanding slightly to lip of calice. Height varies between 15 mm. and 20 mm., but the shortest has the largest calice. Calice variable in shape, probably owing to local surroundings; in some specimens calice is circular, in others oval, while others have various indentations and excrescences. Diameters of calices 15×15 mm., 16×12 mm., 17×10 mm., 18×15 mm., 20×13 mm., 20×18 mm. Costæ visible from base upwards, low broad ridges covered with minute granulations, corresponding to each septum; towards the lip of the calice these costal ridges become more marked, and somewhat stouter and more exsert costæ alternate with slightly smaller costæ. This alternation of larger and smaller costæ is apparent in some specimens at the extreme base of the corallum as well as at the calicular margin. Septa close, not markedly exsert; the size of the septa and the extent to which they are exsert diminish in a descending order of magnitude according to the cycle to which they belong: those of the first cycle are larger than those of the second, the second than the third, and so on. They are uniformly covered with minute granulations, which are arranged in a series of longitudinal and radial rows. The calice is widely open, and the inner margins of the septa are cut up into large irregular nodules representing small pali, which pass imperceptibly into a fasciculate parietal, centrally depressed columella. There appear to be typically five orders of septa, but those of the lower orders are not always easy to interpret. The primaries are always large and extend to the columella; their paliform nodules are slightly larger and more projecting than those of the septa of lower orders; the septa of lower orders tend to fuse together near the columella, and pass into it as an ill-defined mass of minute pali. The larger size of the primary septa and the grouping together of those of other orders give a hexagonal starlike effect to the calice. In none of the seven specimens from the Persian Gulf are the five cycles complete, although in one there are 94 septa, only two septa of the fifth cycle being missing.

In the specimen figured (text-fig. 217), however, there are also

94 septa, but here the arrangement is not so simple: in one lateral chamber on each side between the primary and secondary septa the fifth cycle is unrepresented, there being only three instead of the normal seven septa. On the other hand, in both the apical

Text-fig. 217.



Diagrammatic plan of the septa of *Paracyathus cavatus*. The primary and secondary septa are black, the tertiaries are cross-hatched, the quaternaries are crossed with diagonal lines, the quinaries are left blank; i, ii, iii, iv, v, septa of the first, second, third, fourth, and fifth cycles.

chambers at one end of the long axis there is an excess of septa. In both chambers, between the primary and secondary septa on the one side, and the primary and secondary septa on the other

side, there are more than the normal number of septa. It appears as if the tertiary septa of both these chambers had been split by a wholly superfluous quaternary septum, while in one case a quaternary septum has been further split by a super-numerary quinary. The same phenomenon is apparent to a greater or lesser degree in all the remaining five specimens. In one specimen there is a sudden outpushing of the wall of the calice between a primary and a tertiary septum, in which there are no fewer than nine instead of the normal three septa; in every case there is a costa to correspond with each septum, and the alternation of large and small septa and costae is maintained.

Seven specimens fixed on to a mass of mud, shell and serpulid tubes.

Locality. From Cable 60 miles S.W. of Bushire, Persian Gulf. Depth 30 fms.

Two specimens are infested by the Cirriped *Pyrgoma stokesii*, which forms a bulbous gall within the wall of the coral (Pl. LVII. fig. 5 c). This distortion does not, however, interrupt the regularity of the costae, which are distinctly visible on the outside of the parasitic chamber; nor does the presence of this parasite appear to affect the number of septa; there is no excess or shortage of septa in the attacked specimens beyond that which is normally observed in the unattacked individuals.

Genus TREMATOTROCHUS T. Woods [39].

TREMATOTROCHUS ZELANDIÆ. (Pl. LVII. fig. 4; Pl. LVIII. figs. 15-17).

Conocyathus zelandiæ Duncan [14].

Corallum regularly conico-cylindrical, free, without trace of attachment. No epitheca. Height of largest specimen 7 mm., diameter of calice 3.4 mm. Costae in four complete cycles, prominent, smooth, and equal in the upper part of the corallum. Only those of the first two cycles extend to the base; those of the third cycle extend downwards for about three-quarters, and those of the fourth cycle for a distance varying between a third and three-fifths of the height of the whole corallum. The costae between those of the second and third cycles are longer than the costae between those of the first and third cycles; they do not join those of the preceding cycle, but there is a thickening of the costae of the first three cycles below the point at which that of the succeeding cycle ends. Intercostal furrows penetrated by minute, regularly disposed perforations (Pl. LVII. fig. 4). Calice circular, no fossa. Septa in six systems of three complete cycles, all exsert, those of the first cycle more prominently so than those of the succeeding cycles; very thin and beset with small spinous granulations. Septa of the third cycle join those of the second a short distance below the lip of the calice; they are incomplete at their inner margins, large fenestrations occurring at the point

where the septa of the third cycle join those of the second, and those of the first and second join the columella. The lower fifth of the corallum has been filled up internally by a secondary deposit of calcareous matter, but the outline of the original structure is faintly discernible in photographs of sections at this level, and reveals that the columella is parietal, formed by the union of the inner ends of the septa.

Three specimens.

Locality. Persian Gulf. Depth not recorded.

The genus *Trematotrochus* was proposed by Tenison Woods [39] for a fossil from the Miocene of Australia. The coral had all the characters and appearance of a Turbinoliid, but with the important difference that the wall was penetrated by large perforations between the costæ, giving free communication between the interseptal chambers and the exterior.

This remarkable coral did not receive the attention it deserved, and subsequent authors received sceptically the statement that these perforations were really present; for the point called in question the validity of the division of the Madreporaria into Perforata and Imperforata. Duncan [15] pointed out the difficulty of placing this genus, but referred it to the Turbinoliidæ in close relation with *Turbinolia*, *Stylocyathus*, *Conocyathus*, and *Bistylia**.

In a series of papers published in the Transactions of the Royal Society of South Australia, Dennant [7 & 8] has since described six more fossil forms and one recent form (*T. verconis*) from Australia and Australian Seas. In the first of these papers he describes two species from Eocene and one species from Miocene deposits. The recent species was found in St. Vincent's Gulf and Backstairs Passage at depths of from 15 to 22 fathoms. All have the characteristic perforations, which fact caused him to remove the genus altogether from the Turbinoliidæ and place it among the Eupsammiidæ. Later he described three different species from older Eocene beds than those in which his previous species were found, and in two of these the perforations do not pierce the wall, but are merely pore-like cavities extending half-way through the thickness of the wall like the intercostal dimples of some Turbinoliidæ. This made him put the genus back among the Turbinoliidæ, and he referred to Gregory's [23] suggestion that the Perforate type of coral has been derived from the Imperforate. He further remarked on the wide distribution through time of the original species *T. fenestratus*, and appended a drawing of a portion of the wall of one of them, placing the existence of the pores beyond all suspicion of doubt. All the previously described species come from Australia, and Dennant pointed out the

* Duncan uses the phrase "one of the species" as if more than one species were known. At the time of the publication of his paper (1885) I am not aware that any other species had been described.

occurrence of a recent form as evidence of the close relationship between the living and fossil fauna of that country. He made no attempt to discuss the significance of these forms in connection with the existing classification of the Madreporaria, but dismissed the subject with the single statement—"the broad distinction usually made between perforate and non-perforate corals breaks down."

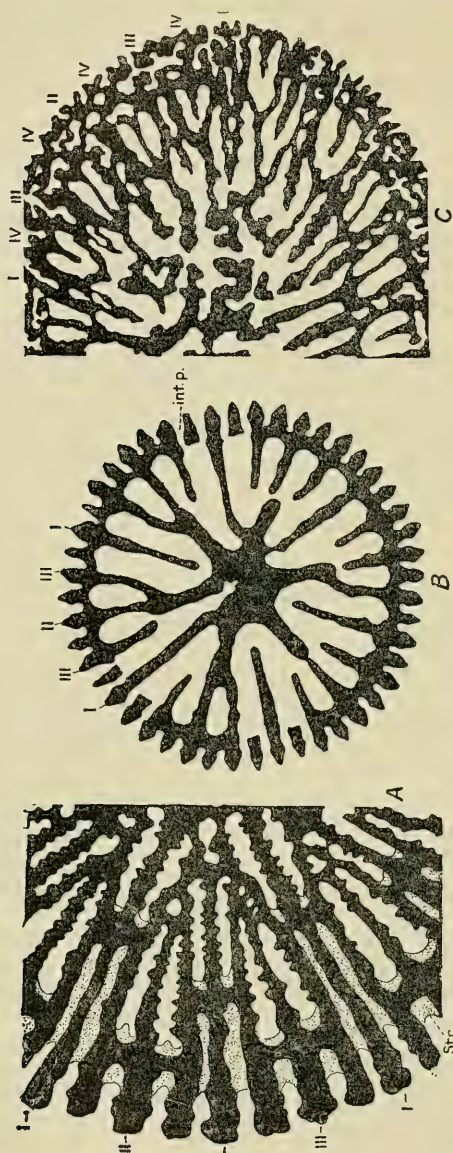
The occurrence of another recent species of this problematical genus again forces the subject on the attention of the systematist. That it is a *Trematotrochus* is, I think, unquestionable. It agrees with Dennant's latest definition in all points but one:—He has described the septa as being solid; but in *T. zelandiæ* the septa are incomplete, large fenestrations occurring at the point at which the tertiaries join the secondaries, and the primaries and secondaries join the false columella. Realizing that the existence of these fenestrations and of the pores in the outer wall might again be doubted (having already admitted that these latter are minute and difficult to see), I have ground sections of one specimen, thinking that actual photographs would be more convincing than external observations. These sections have been made at intervals of $\frac{1}{20}$ mm. and the entire coral has been ground away; every section was photographed at a magnification of 20, and from these photographs a wax model has been constructed. There is, therefore, a permanent record of the structure of this most interesting coral, and it would be idle to deny the existence of either thecal pores or septal fenestrations. But in spite of this, I think that it is rightly placed among the Imperforate corals.

In text-fig. 218, A and C are diagrammatic representations of transverse sections of portions of the wall of a *Heterocyathus* and a *Heteropsammia* (after Bourne [6]), for comparison with B, a transverse section of *T. zelandiæ*. The *Heterocyathus* has a solid theca embedded in stereoplasm. The *Heteropsammia* has a porous spongy wall. A glance at the *Trematotrochus* will show that the extremely thin wall is incomplete, and that here and there are small communications between the interseptal chambers and the exterior; but it could not be regarded as a "porous ctenenchyme" such as is diagnostic of the division Perforata. The condition is much more that of a Fungiid which has grown conically instead of spreading out with a widely open oral surface, with that part of the wall between the perforations representing synapticula. In some of the fossil forms the perforations are so large and the intervening solid structure little more than a narrow bar, that the comparison with synapticula is more striking than in the present instance. The analogy, however, must not be pressed too far, but it widens the gulf between *Trematotrochus* and the Perforata, and tends to justify its inclusion among the Imperforata.

Another point to be emphasized is the localities in which the species are found. Hitherto the eight species of the genus were

all found in the limited area of Australia and the seas round that continent and New Zealand; but now we find it in the

Text-fig. 218.



A. Portion of a diagrammatic section through the corallum of *Heterocyathus aquicostatus* (after Bourne).

B. Diagrammatic section through the corallum of *Trematotrochus zelandiae*.

C. Portion of a diagrammatic section through the corallum of *Heteropsammia michelini* (after Bourne).

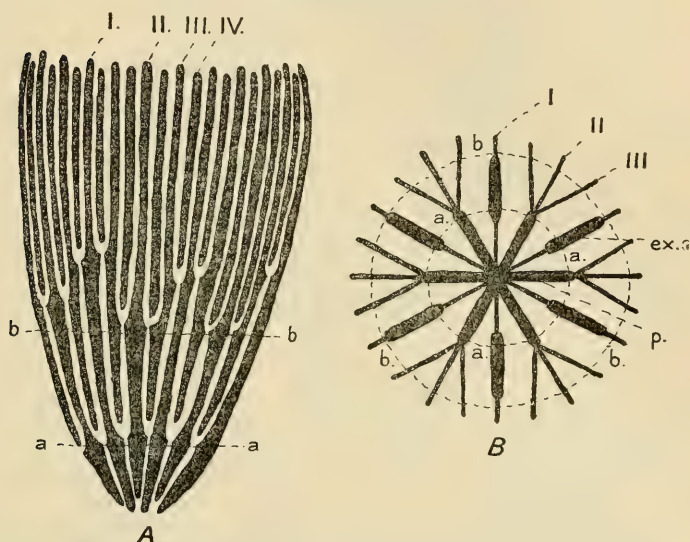
i, ii, iii, iv, septa of the first, second, third, and fourth cycles; *Str.*, stereoplasm; *int. p.*, intercostal pores.

Persian Gulf. The identity of the last with *Conocyathus zelandiae* has already been pointed out in the introductory remarks of this

paper, and the occurrence of the same species in localities so far apart is remarkable.

I had hoped that the sections might throw some further light on the question of septal sequence, but unfortunately the lower fifth of the coral has been filled up solidly by a secondary deposit of calcareous matter, and the interseptal chambers do not begin to appear distinctly until a level is reached where twelve septa and twenty-four costæ are already present. If it

Text-fig. 219.



- A. Diagrammatic plan of the costæ of *Trematotrochus zelanliæ*, showing the difference in length of the costæ of the fourth cycle. i, ii, iii, iv, costæ of the first, second, third, and fourth cycles.
- B. Diagrammatic plan of the septa of *Trematotrochus zelanliæ*, representing the exsert peripheral portion of the primary septa, and the exsert pali of the secondary septa. i, ii, iii, septa of the first, second, and third cycles; *ex.s.*, exsert portion of the septa of the first cycle; *p.*, pali.

may be taken that the costæ correspond to the septa and that the base of a coral represents the earliest formation, it might be objected that Pourtalès' law for septal sequence has not been followed in this case; for the costæ which extend to the base, twelve in number, are those corresponding to the first and third (according to Pourtalès [35]) cycles of septa. That is to say, if the secondary septa split peripherally in a Y-shape, and a tertiary septum grew up between the arms of the Y, the septa generally spoken of as secondary and tertiary are named

conversely to the order in which they appear in ontogeny. But it must be remembered that the stem of the Y is also the representative of the secondary septum according to either the popular or Pourtalès' nomenclature; and these septa still exist in their normal position midway between the primary septa, and project upwards as pali, or paliform lobes: in the lower portion of the colony, before the secondary septa have begun to branch, the costæ corresponding to them are also unbranched, and extend to the base. A comparison of the diagrams A, B, in text-fig. 219, illustrates this point.

Diagram A represents a plan of the costæ and B a plan of the septa; in A a line "aa" has been drawn across the lowest part of the corallum, and in B a corresponding circle "aa" has been drawn round the inner part of the septal plan; in both, the costæ and septa respectively of the first and second cycles are present; presumably the coral must at one time have passed through a stage when these cycles only were present. In *T. fenestratus* this is the arrangement in the adult. Again, another line "bb" is drawn across A at a higher level and a corresponding circle "bb" on B; in both, the costæ and septa of three cycles are present. When the secondary septa branched peripherally, new costæ arose in connexion with these branches, and the original secondary costæ remained in connexion with the inner unbranched part of the secondary septa which persist as pali or paliform lobes. Bourne [6, text-fig. I. 2] has given a comprehensive diagram illustrating the relation of septa and pali according to Pourtalès' principle: diagram B illustrates the arrangement in *T. zelandica*, which is entirely in agreement with it.

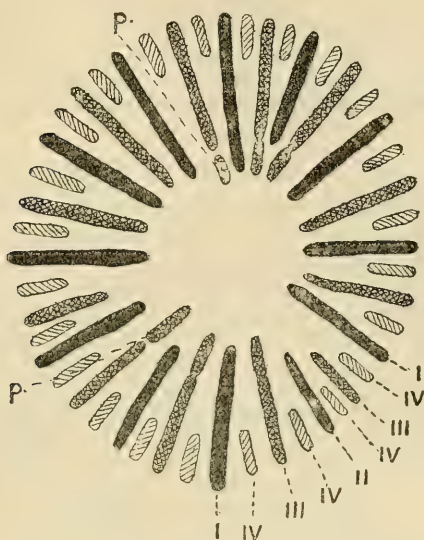
The fact that the costæ of the fourth cycle are of different lengths (see text-fig. 219 A, iv) is in accordance with Duerden's [11] account of the septal sequence of *Siderastrea radians*, in which he states that new mesenterial pairs appear in some interseptal chambers, before those in others of the same cycle.

AGELECYATHUS PERSICUS Duncan [14].

Corallites rising from an encrusting base, expanding slightly from base to calice. Calice elliptical, depressed at one end of the long axis. Height of corallum from 5-10 mm. at depressed end of the long axis, and from 15-20 mm. at the opposite end. Diameter of calice 9×7.5 mm. to 11×9 mm. The shape of the corallites suggests that the colony was fixed on a vertical surface, and the inequality of height in the two extremities of the long axis is a response to an effort on the part of the individual corallites to assume a vertical position. Costæ in four complete cycles, distinct from base upwards, slightly exsert and finely granular. Septa in six systems of four cycles of which the last is incomplete, although all the costæ of the fourth cycle are present; septa of the first two cycles more exsert than those of the third cycle; all three cycles reach the columella;

septa beset with minute granulations arranged in radial ridges. An incomplete single crown of pali before the septa of the third cycle. Columella fascicular.

Text-fig. 220.



Diagrammatic plan of the septa of *Agelecyathus persicus*. Septal orders represented as in text-fig. 217. Six detached pali are represented. i, ii, iii, iv, septa of the first, second, third and fourth cycles; p., pali.

A single specimen consisting of five individual corallites arising from a common encrusting base.

Locality. From Cable 60 miles S.W. of Bushire, Persian Gulf. Depth 30 fms.

Before some of the septa of the third cycle there are distinct upwardly projecting lobes corresponding to pali. Thus in the calice figured (text-fig. 220) there are six such pali opposite six septa of the third cycle, three at each end of the long axis; there are two less conspicuous lobes before two septa of this cycle, while the remaining four septa of the third cycle have no trace of any such lobe. Milne-Edwards and Haime [29] divided the family Turbinoliidae into two sub-families—the Turbinolinæ without pali, and the Caryophyllinæ with pali; and this classification has found more favour with subsequent authors than Duncan's [15] later classification, which divided the family into *Turbinolidæ simplices*, *Turbinolidæ gemmantes*, and *Turbinolidæ reptantes*, according to their habits of growth and reproduction. This coral affords evidence in favour of Duncan's classification; indeed it would be difficult to know in which of Milne-Edwards'

and Haime's groups to place it, for here in a single calice is a combination of the diagnostic characters of the two sub-families: pali are present before some and not before other septa of the same cycle.

This specimen is considerably larger than Duncan's original example from the same locality, and differs from his figure of the type specimen in having the septa in the first two cycles much exsert; but he calls attention to the variability of the pali, the size and the number of the septa, as being features of the individual corallites. The similarity in other details is close.

Family FUNGIIDÆ.

FUNGIA PATELLA Ellis & Solander [16].

Three specimens from the Persian Gulf which are identical with Döderlein's figure [10, pl. i.] of the *Cycloseris*-form of *F. patella*, Wayland Vaughan's figure [40, pls. xxvii. & xxviii.] of *F. patella*, and Gardiner's figure [18, pl. xix.] of *Cycloseris hexagonalis*. They afford further evidence of the wide distribution of the species, and for the justification of absorbing the genus *Cycloseris* in the genus *Fungia*.

Locality. Two specimens from Shaikh Shuaib Island, Persian Gulf. Bottom, rock. Depth 10 fms. Exact locality of third specimen not recorded.

Family EUPSAMMIIDÆ.

HETEROPSAMMIA APHRODES Alcock [1].

Eight specimens each with a single calice. The inflated spongy exsert edges of the septa of the first two cycles are well developed.

Locality. Telegraph Cable, Persian Gulf. Depth 40 fms.

DENDROPHYLLIA sp. ? de Blainville [5]. (Pl. LVII. fig. 7.)

Colony bushy, springing from an encrusting base on which are numerous small individuals. Budding lateral or basal. Polyps occasionally joined by horizontal bars, but in every case such bars are inhabited by a small commensal worm, and have probably been formed in connexion with this parasite. Polyps tend to assume a vertical position, but one polyp which appears to arise from a horizontal bar is directed downwards. Size of the polyps very variable; some scarcely rising from the encrusting base; some attaining to a height of 25 mm. Calice varies between 2×2 mm. in the youngest to 7×6 mm. in the oldest individuals. Costæ distinct from base upwards, equal, granular, not exsert, correspond in number to the septa. Septa in six systems of four cycles with a few representatives of the fifth cycle, all irregular. Some septa of the lower cycles are grouped together round that of the preceding cycle in the typical dendrophylliid manner, while others extend to the columella, and are equal in size to those of preceding cycles. All septa are

finely granular, the lower orders are perforate. Calicular fossa very deep. Columella fascicular, parietal; well developed in older individuals.

Locality. From Cable 60 miles S.W. of Bushire, Persian Gulf. Depth 30 fms.

With only a single specimen of a coral such as this, which exhibits such a wide range of variability, the creation of a new species has not seemed to me justifiable. I have, therefore, merely noted its characters and appended a photograph of the specimen, until such time as it may be found in greater numbers.

Note on Miss Harrison's memoir on some Madreporaria from the Persian Gulf, and some further notes on *Pyrophyllia inflata*. By SYDNEY J. HICKSON, M.A., F.R.S., F.Z.S.

The manuscript of Miss Harrison's paper was sent to me shortly before she left this country for India, with a request that I would read it and revise it for publication. The number of species in the collection is small and there is only one that is new to science, but there are several points in the paper which it seemed to me required rather fuller consideration than she has given to them, and I have ventured therefore to write an addendum, leaving her original memoir intact. Had she remained in England I would have suggested the inclusion of these remarks in her paper, but under the circumstances, I think it is better to publish them under a separate title and thereby take the whole responsibility for them. I have rearranged the order of the species, furnished the list on p. 1019, and added the family names, but in other respects the paper is as it left her hands.

At the present time our knowledge of the fauna of the Persian Gulf is very limited. None of the great deep-sea exploring expeditions have visited it, and independent investigators with sufficient knowledge and energy in this region have been few and far between.

Mr. F. W. Townsend, of the telegraph staff of the Indian Government, has made a large and valuable collection of shells, and these have been described in a series of papers by Cosmo Melvill and Standen,* but so far as I can discover, very few genera and species belonging to other groups of marine animals have been recorded. The richness and interest of the Molluscan fauna suggests that many new forms have still to be discovered in the Gulf, but the subject of special importance that the study of this fauna would shed light upon, is the relation of the fauna of the Persian Gulf to that of the Mediterranean Sea. It has frequently been suggested that in the past there was a connexion between the Indian Ocean and Atlantic Ocean by way of the Mediterranean Sea; and, judging by the present day geographical features, it is probable that the last connexion between them

* For list of papers see Proc. Zool. Soc. 1906, p. 783.

was broken by the formation of the Isthmus of Suez. But the last connexion but one was that by way of a strait, of which the remaining part is now the Persian Gulf; and this gulf with its narrow outlet into the Indian Ocean, high temperature and great rivers, might be expected to retain some of the fauna which had been subject to very similar conditions in the South-east corner of the Mediterranean Sea. Melvill and Standen call attention to the considerable generic analogy between the Mollusca of the two regions, and point out that the species of the Persian Gulf show close affinities with South-European forms.

It would be quite premature to draw any far-reaching generalisations as to the distribution of Madreporaria from the few specimens that are here recorded, but attention may be called to one or two points of general interest.

The occurrence of *Pyrophyllia* in deep water in the Persian Gulf is interesting from the point of view of geographical distribution. Alcock [3] in his comments on the deep-sea Madreporaria of the Indian Ocean, calls attention to the "many intimate affinities of the fauna of moderate depths of the Indian seas with the North Atlantic fauna," and considers them "to be sufficient to suggest a direct sea-connexion, in the past, between the Atlantic and Indian Oceans, and the case of *Caryophyllia communis* and *Flabellum laciniatum* would indicate that the connexion was by way of the Mediterranean."

The case of *Pyrophyllia* and *Guynia* appears to me to give even stronger evidence of the truth of this hypothesis, than that of the two species quoted. The genera *Caryophyllia* and *Flabellum* are both very widely distributed recent corals, and it is possible that in comparatively recent times these two species may have had an almost cosmopolitan distribution. *Guynia* and *Pyrophyllia* are, so far as is known at present, very restricted in their distribution and are totally unlike any other recent coral—with the possible exception of the West Indian genus *Haplophyllia*.

Although so much alike in important characters, they are sufficiently distinct for us to believe that they were separated from one another at a very remote period. It is rather more difficult to believe that the Indian Ocean and Mediterranean specimens of *Caryophyllia communis* and *Flabellum laciniatum* can have undergone no differential change since the time when the Mediterranean Sea and the Indian Ocean were in communication. A second point of interest is, that the only other coral with which *Pyrophyllia* shows affinities, namely *Conosmilia*, should be found in the Tertiary deposits of Australia. Standing by itself, this is only one of those facts of geographical distribution which it is important to note but impossible to explain in a satisfactory way. But its importance as a fact is emphasized when it is placed side by side with the facts of the distribution of *Trematotrochus*.

As Miss Harrison points out, the specimens of *Trematotrochus*

found in the Persian Gulf are closely related to species of corals from the Tertiary deposits of Australia, and to a recent coral found at depths of from 15 to 22 fathoms in St. Vincent Gulf,* and identical with a recent coral from "no very great depth" in Cook's Strait, New Zealand.

Of the geographical distribution of the other species very little need be said. *Heterocyathus heterocostatus* is new, but a closely related species *H. æquicostatus*, of which one specimen was found, appears to be widely distributed in the Indian Ocean. *Paracyathus cavatus* is found in the Indian Ocean and is said by Alcock to be closely related to the Eocene fossil *P. crassus* from the London Clay. *Agecyathus persicus* was previously recorded by Duncan from the Persian Gulf, but was said to occur also off St. Helena. *Fungia patella* occurs in the Indian Ocean. The type specimen of *Flabellum magnificum* was found off Sumatra at a depth of 470 metres. The genera *Heteropsamnia* and *Dendrophyllia* appear to be widely distributed in the Indian Ocean. So far then as this small collection of corals is concerned, *Pyrophyllia inflata* is the only species that even suggests a former connexion of the Gulf with the Mediterranean Sea.

The genus *Pyrophyllia* was briefly described in the "Manchester Memoirs," 1910; but it may be convenient to take this opportunity of adding a few general remarks on the genus and of publishing some further illustrations (Pl. LVII. figs. 8-11; Pl. LVIII. figs. 18, 19).

Pyrophyllia inflata is a small unattached solitary coral, of about 4 to 5 mm. in length, and 1 mm. in diameter at the margin of the calyx.

The two most important characters are:—(1) Its very pronounced and invariable octoradiate symmetry, and (2) the presence on the external surface of well-marked accretion ridges with short but definite costal spines (text-fig. 221).

Pyrophyllia is related to the recent genus *Gygnia*, and to the extinct Tertiary genus *Conosmilia*. The number of septa in *Pyrophyllia* and in *Gygnia* is sixteen, and of these eight are larger and may be called the primary septa, and the remaining eight are smaller and may be called the secondary septa.

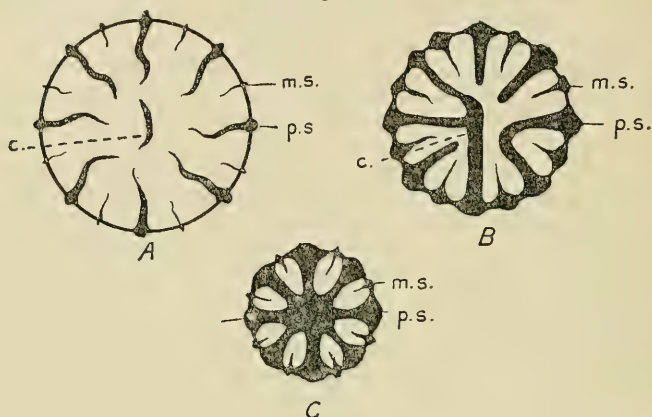
In *Gygnia* one of the eight primary septa is larger than the others, this large septum being according to Duncan a "very marked rugose peculiarity." Moreover, in *Gygnia* four of the primary septa are sometimes larger than the other four, so that according to Duncan the system of septa is four primary septa, four secondary septa, and eight tertiary septa.

In these respects and in others of less importance, *Gygnia* seems to be distinct from *Pyrophyllia*. In the genus *Conosmilia* there is a more variable arrangement of the septa. In *C. elegans*, *C. lituolus*, and *C. anomala* there are eight primary septa, eight secondary septa, and thirty-two tertiary

* The specimens of this coral *T. verconis* were much worn and were no doubt dead corals when collected.

septa; but in *C. striata* there are only six primary septa, six secondary septa, and twelve tertiary septa. The more recently described species of this genus, *C. granulata* and *C. stylifera* (Dennant 7), agree with *C. striata* in the hexaradial arrangement of the septa. In *Conosmilia*, moreover, the accretion ridges do not appear to exist unless they are represented by the "beautiful herring-bone ornamentation of the surface."

Text-fig. 221.

Diagrammatic sketches of the septal arrangement of *Pyrophyllia inflata*.

c., columella; m.s., secondary septa; p.s., primary septa.

- A. Arrangement of the septa just below the margin of the calyx. B. At the base of the calyx. C. In the lower parts of the coral. (From Mem. Manch. Lit. Phil. Soc. 1910.)

The columella of *Conosmilia* resembles *Pyrophyllia* in being laminate and in this respect differs from *Guyonia*, in which the columella is cylindrical.

There has been a great deal of hesitation in giving the two genera *Guyonia* and *Conosmilia* a definite resting-place in the system of corals.

Duncan* at first placed the genus *Guyonia* in the Order Rugosa and in the family Cyathaxoniidae, but subsequently removed it [15] to the family Turbinoliidae. Miss Ogilvie placed it in her new family Amphistraeidae†.

Duncan‡ at first placed the genus *Conosmilia* in the Order Rugosa, family Stauridae, but subsequently removed it to the family Astraeidae Simplicies and placed it close to the genus *Trochasmilia*. Miss Ogilvie placed this genus in the family Turbinoliidae.

In my preliminary account of the genus, I remarked that "it cannot be denied that *Pyrophyllia* has some characters reminiscent of the extinct Rugosa," but on reconsideration I do not feel

* Phil. Trans. R. S. 1872.

† Phil. Trans. 1896.

‡ Phil. Trans. 1872.

satisfied that these characters—the octoradiate symmetry, the pronounced accretion ridges and the septal fusions in the lower part of the coral—really indicate any true affinities with Palæozoic corals. Duncan found one specimen of *Guyonia* in which, owing to the abortion (?) of two septa, the upper part of the corallum showed a hexaradiate symmetry. This specimen was regarded by him as “very suggestive in the matter of the evolution of the hexamerous from the octomerous types, or rather from the tetramerous.” But the view that was in his mind, that the modern hexaradiate corals are descended from a previous tetraradiate type, is not one which commends itself to more recent investigators of coral structure. The researches of Duerden* suggest that the tetraradiate symmetry of Rugose corals is derived from a more primitive hexaradiate symmetry, and there is no evidence in the development of modern corals, or satisfactory evidence in palæontology, that the modern hexaradiate corals are derived from a previous tetraradiate or octoradiate ancestry.

It is true that many Palæozoic corals exhibit four dominant primary septa, but there are none with eight dominant septa. The true octoradiate condition is known only in certain species of the Tertiary genus *Conosmilia* and in the recent genera *Guyonia* and *Pyrophyllia*. The recent genus *Haplophyllia* has also eight primary septa and eight secondary septa, but it is suggested by Gardiner that this genus is only a growth stage of *Duncania*. The close relationship of *Conosmilia* to the simple modern hexaradiate corals suggested by the classification of Duncan and of Ogilvie, seems to point to the conclusion that the Guyniidae represent an early offshoot of the modern hexaradiate line of descent, and that their true affinities lie rather with the modern Turbinoliidae than with any known Palæozoic coral.

I may refer in conclusion to some remarks made in my preliminary paper on the presence of endotheca in *Pyrophyllia*. Although Duncan's definition of endotheca is not very explicit, I have come to the conclusion that there is no structure in *Pyrophyllia* that really corresponds with what is usually regarded as endotheca by the palæontologists. A longitudinal section of a *Pyrophyllia* (Pl. LVIII. fig. 19) shows three regions: an upper calicular region (*x*) in which the septa are free from one another and from the columella, a middle region (*y*) in which the septa are more or less irregularly fused with one another and with the columella, and a lower region (*z*) in which the septa are again free and the thecal wall inflated.

It seems probable from the texture of the well-preserved specimens that the living tissues were confined to the upper calicular region. The growth in thickness and the fusion of septa and columella in the middle region (see text-fig. 221) perform the same function as the endotheca of Palæozoic corals, as they “unite septa, close the loculi, and enable the coral to grow in height and strength, and limit the growth downwards of mesenteries

* Ann. N. H. xviii. 1906.

and soft parts," but there are no thin plate-like structures corresponding with those that constitute the greater part of the endotheca of Palæozoic corals.

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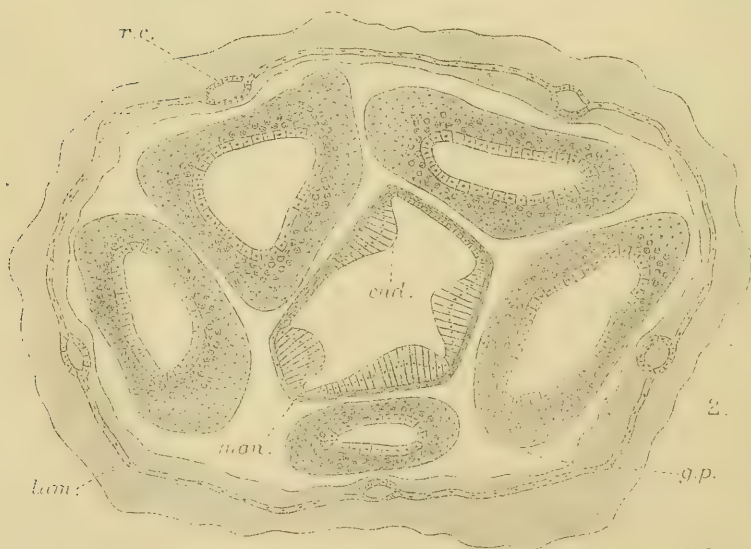
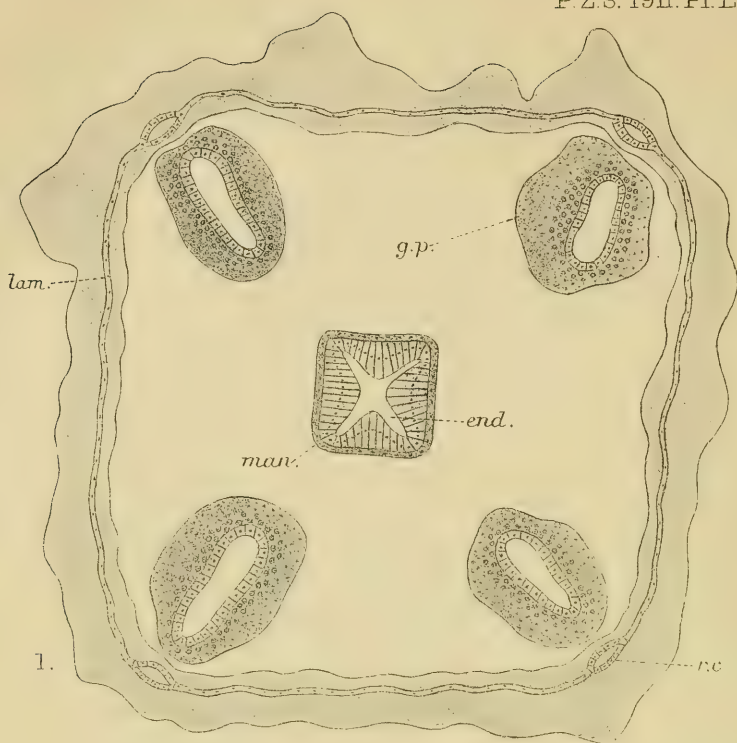
EXPLANATION OF THE PLATES.

PLATE LVII.

- Fig. 1. *Flabellum magnificum* von Marenzeller. Viewed from above. $\times \frac{2}{3}$ diam.
2. *Flabellum magnificum*. Viewed from below to show the tubular rootlets of attachment.
3. *Flabellum magnificum*. Side view.
4. *Trematotrochus zelandiæ* Duncan. Transverse section of the coral. \times ca. 12 diam. Compare text-fig. 218 B, p. 1032.
5. *Paracyathus cavatus* Alcock. A. View of a vertical fracture. B. View from above. C. Side view showing on both sides above, galls formed by *Pyrgoma*. Nat. size.
6. *Heterocyathus heterocostatus*, sp. n. Nine specimens showing the variations in height. \times 2 diam.
7. *Dendrophyllia* sp. ? $\times \frac{2}{3}$ diam.
8. *Pyrophyllia inflata*. Side view. \times 5 diam.
9. *Pyrophyllia inflata*. View of the mouth of the calyx showing the columella and primary septa.
10. *Pyrophyllia inflata*. View of a specimen that has been broken in half longitudinally showing the irregular arrangement of the fused septa in the lower regions of the coral.
11. *Pyrophyllia inflata*. View of a specimen showing the fusion of the eight primary septa and the secondary septa. Compare text-fig. 221 B, p. 1040.

PLATE LVIII.

- Fig. 12. *Heterocyathus æquicostatus* M.-E. & H. Two adjacent costæ which are low broad ridges covered all over with uniform fine granules, the intercostal furrows being small and shallow. This specimen belongs to Gardiner's Type I.
13. *Heterocyathus alternatus* Verrill. Two adjacent costæ. The costæ on the right (A) is the type of costa corresponding with the septal cycles i, ii, and iii. The costa on the left corresponds to the septal cycle iv. The intercostal furrows are deep. This specimen belongs to Gardiner's *H. æquicostatus* Type II.
14. *Heterocyathus heterocostatus*, sp. n. Side view. \times ca. 14 diam.
15. *Trematotrochus zelandiæ* Duncan. Side view. \times ca. 12 diam. Compare text-fig. 219 A, p. 1033.
16. *Trematotrochus zelandiæ*. View of the base.
17. *Trematotrochus zelandiæ*. View of the calyx from above. Compare text-fig. 219 B.
18. *Pyrophyllia inflata* Hickson. View of the calyx showing the columella, the eight primary septa, four of the eight secondary septa, and the lines of accretion.
19. *Pyrophyllia inflata*. Longitudinal vertical section showing the fusion of the primary septa in the lower parts of the coral. *x*, region of the calyx; *y*, middle region; *z*, inflated base.



Hub. h. et u. a.

47. On Variation in the Medusa of *Mærisia lyonsi*. By CHARLES L. BOULENGER, M.A., F.Z.S., Lecturer on Zoology in the University of Birmingham.

[Received May 23, 1911: Read June 27, 1911.]

(Plate LIX.* & Text-figures 222-228.)

In 1908 I published an account [1]† of a new lacustrine Hydromedusan, *Mærisia lyonsi*, obtained by Dr. Cunningham and myself from the brackish waters of Lake Qurun in the Fayûm Province of Egypt.

In my paper, whilst describing the anatomy of this interesting form, I called attention to the fact that the number of tentacles and radial canals in the medusa stage was subject to much variation, and mentioned that in a series of 400 individuals which I examined, 55, or nearly 14 per cent., differed from the normal.

My description of the abnormal specimens was very short, and it has been suggested to me that it would be of interest to furnish a more detailed account of the variation of this medusa, as well as to figure some of the more peculiar abnormalities. This I was all the more prepared to do, as further study of the collection had revealed additional points of interest in connection with this phenomenon.

Variation is known to occur frequently in jelly-fishes‡, and in some species it has been very carefully studied; although in many cases the series dealt with were numerically far greater than the one at my disposal, I know of no form in which such a variety of abnormalities occur as in *Mærisia*. The interest of the series I am about to describe is not diminished by the fact that all its members were collected in one locality and belong to the same sex.

As the greater part of my material had already been distributed when I decided to take up this subject again, it was necessary to re-examine the specimens in the Natural History Museum, London, and in the Cambridge Museum of Zoology; for permission to do this, I have to thank Mr. R. Kirkpatrick and Mr. L. Doncaster, under whose charge the specimens are preserved in these institutions.

In my description of *Mærisia lyonsi*, I drew up the following table to show the number and arrangement of the radial canals

* For explanation of the Plate see p. 1056.

† The figures in brackets refer to the List of References on p. 1055.

‡ Cf. List of References on p. 1055.

and tentacles in 400 medusæ taken at random from the material at my disposal:—

Table showing the Number and Arrangement of the Radial Canals and Tentacles in 400 individuals.

Number of Individuals.	Number of Radial Canals.	Number of Tentacles.				
		Perradial.	Interradial.	Adradial.	Subradial.	Total.
1	3	3	—	—	—	3
345	4	4	—	—	—	4
1	4	4	1	—	—	5
1	4	4	1	2	—	7
1	4	4	—	1	—	5
2	4	4	2	4	—	10
10	4	4	4	—	—	8
28	4	4	4	8	—	16
1	4	4	4	8	6	22
9	5	5	—	—	—	5
1	6	6	—	—	—	6
Total 400						

It will be noticed that the 55 abnormal individuals fall naturally into two well-marked groups:—(a) which includes those medusæ which deviate from the normal tetramerous symmetry; and (b), which includes medusæ with the normal number of radial canals and primary, perradial tentacles, but possessing, in addition, secondary tentacles situated between the four primary ones and not connected with the stomach by means of radial canals.

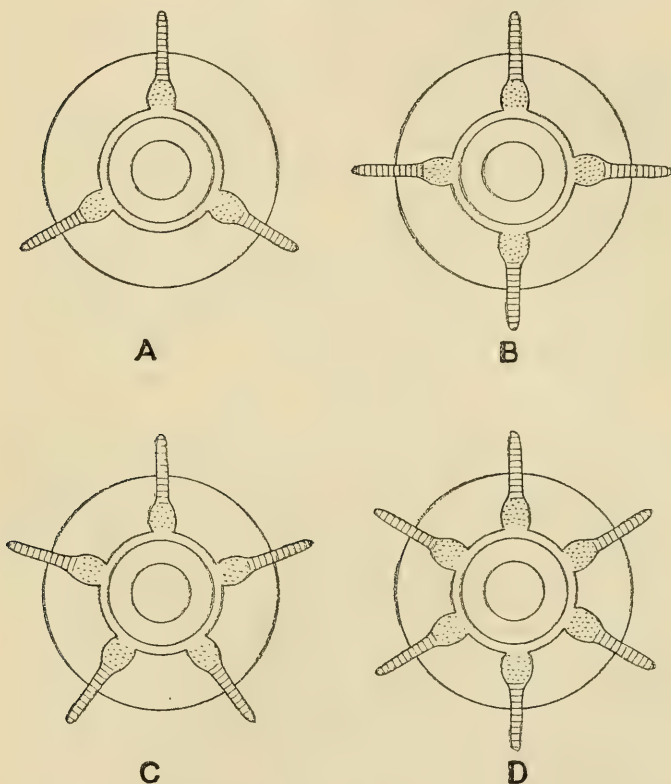
It is my intention to discuss these two groups separately, as it is obvious that in them we are dealing with two completely distinct phenomena.

(a) The normal medusa of *Mærisia lyonsi* is provided with four radial canals at the distal extremities of which the four perradial tentacles are given off. The gonad-bearing region of the stomach is produced into four perradially situated pouches which in the adults extend as finger-shaped diverticula for a considerable distance along the radial canals.

Eleven specimens out of the 400 medusæ examined (*i. e.* 2.75 per cent.) were found to deviate from this general tetramerous symmetry; one medusa possessed only three radial canals, three tentacles and three gonadial diverticula; nine medusæ had five, and one had six of these structures. This type of variation is known to occur in many species of medusæ which are normally tetramerous in symmetry; among craspedote forms it has been studied best in *Obelia* (*Eucope*) [2], *Clytia* [3], *Sarsia* [4, 5], *Rathkea* (*Lizzia*) [7], *Podocoryne* [8], *Gonionemus* [8], and *Limnocoñida* [9].

Limnocnida being another African lacustrine form is of particular interest. Günther found that out of 70 individuals collected by Dr. Cunningham in Lake Tanganyika, 54 medusæ showed the typical number (four) of radial canals, whilst 16, or 24 per cent., had five or more; as in the case of *Mærisia*, specimens with five radial canals were commoner than those with a larger number. Günther, however, found no medusæ with only three canals, but such trimerous forms have been described in other genera, e. g. *Podocoryne* [8] and *Rathkea* [7].

Text-fig. 222.

*Mærisia lyonsi*.

Diagrams to show the arrangement of the tentacles in four medusæ.

B represents the normal tetramerous form.

Similar variations occur in several members of the Scyphomedusæ: perhaps the most complete account of the phenomenon is that given by E. T. Browne for *Aurelia aurita* [11, 12]. This author examined the variation in the number of tentaculocysts in the ephyra larvæ and adults of the jelly-fish, and found that

20.9% and 22%, respectively, were abnormal, the number of these sense-organs ranging between 6 and 15, the normal number being, of course, 8. These figures, however, include a number of specimens which are undoubtedly teratological monstrosities.

Browne pointed out that variation in the number of tentaculocysts does not necessarily interfere with the other organs of the body, but that there is a correlated variation between the number of genital pouches and buccal arms as shewn by eight specimens:—4 individuals had 3 genital pouches and 3 buccal arms, 1 had 5 pouches and 5 arms, and 3 had 6 of these organs.

In *Maerisia* there must necessarily be a correlation between the number of primary tentacles and radial canals, since recent researches on the development of the gonophores of Hydromedusæ [13, 14] have shown that these structures arise together from the endodermal pouches of the young medusa-bud.

There is also a correlated variation between the number of radial canals and gonadial pouches, and this is only what we should expect as the latter structures spread outwards from the stomach on to the radial canals. The single 6-rayed specimen, however, had one gonadial pouch very poorly developed although the other five were quite normal.

It is interesting to note that variation in the number of primary radii in the medusa does not necessarily affect the symmetry of the manubrium; this point is well shown in the sections figured on Pl. LIX.

A normal medusa with four tentacles, radial canals and gonadial diverticula has the distal part of the manubrium provided with a similar number of conspicuous endodermal ridges or *tæniolæ*, which can be seen in the section figured (Pl. LIX. fig. 1); a similar section through a pentamerous individual (Pl. LIX. fig. 2) demonstrates the fact that, although five canals and gonads are well developed and the manubrium appears almost pentagonal, the number of endodermal ridges is not affected, although their symmetrical arrangement is disturbed.

The above is in accordance with the observations of other investigators:—Agassiz and Woodworth [2] examined 4000 specimens of *Obelia* (*Eucope*), but noted no variations in the shape of the digestive cavity or in the number of the actinal lobes of the manubrium, even in specimens with five or six radial canals in place of the normal number (four) the actinal lobes being always found to be four in number.

A. G. Mayer [3] has also made some interesting observations which bear on this point. This author has made a careful study of the medusa *Pseudoclytia pentata*, the only Leptomedusan which is normally pentamerous, and which he considers to be derived from some species of *Clytia* (*Epenthis*), e.g. *C. folleata*. In *Pseudoclytia pentata* there is much variation both in the number of radial canals and in the number of oral lips; but whilst the former incline towards the production of more than five canals, the oral lips show a decided tendency to revert to the ancestral condition of four.

As mentioned before, variation in the number of radii is of common occurrence in medusæ, and in the above-described varieties of *Merisia lyonsi* we are undoubtedly dealing with a quite ordinary case of meristic variation. As Bateson remarks in his well-known book on the Study of Variation [15]:—"In radial series phenomena analogous to those of the variation in linear series are seen in their simplest form. Just as in linear series the number of members may be changed by a reconstitution of the whole series so that it is impossible to point to any one member as the one lost or added, so may it be in the meristic variation of radial series: and again as in linear series, single members of the series may divide. Between these there is no clear line of distinction."

In the abnormal specimens of *Merisia*, I do not think that we are dealing with cases of division or suppression of one or more radii; from what we now know of the development of medusa-buds [13, 14], it seems that the variation is in the number of radial pouches formed in the early bud.

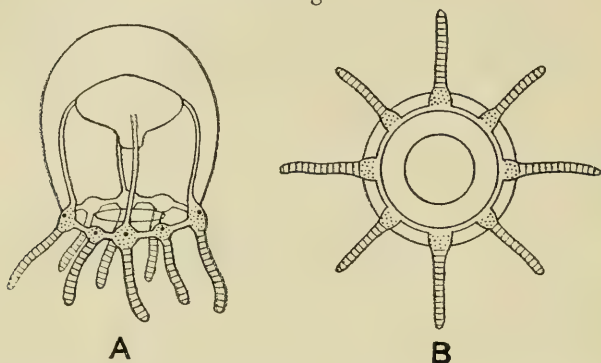
Since each pouch develops the radial canal and perradial tentacle of its own section of the medusa-bell, such variation explains the correlation of the numbers of these two sets of organs. The fact that the manubrium is independent of the organs situated in the umbrella is a point decidedly in favour of this view. I have, unfortunately, not been able to study the development of an abnormal specimen, all the medusa-buds I have sectioned proved to be of normal tetramerous symmetry.

(b) The second group of abnormal individuals includes a number of tetramerous medusæ which bear secondary tentacles between the four primary perradial ones. These secondary tentacles may be interrarial, adradial or subradial in position, and differ from the perradial ones in not communicating with the gastric cavity by means of radial canals; they are developed from the ectodermal and endodermal cells of the umbrella-margin, their cavities being in communication with the circular canal.

Altogether 44 of the 400 tabulated individuals exhibited this kind of abnormality, which is of a very peculiar type; I have not been able to find any record of a similar case in a medusa which normally bears primary tentacles only. There are, of course, numerous tetramerous medusæ which normally possess such secondary tentacles (e. g., *Podocoryne*, *Turritopsis*, *Oceania*, *Limnocyda*), and they are known to start life with the four primary ones only, the secondary tentacles being developed as the animals grow, usually in some definite sequence. Thus, in the majority of cases, the second set of tentacles to appear is the interrarial one, four of these structures growing simultaneously from the umbrella-margin between the four perradial tentacles. Eight adradial tentacles are formed next, two in each quadrant occupying the interspaces between the interrarial and perradial ones, and their formation may be followed by the appearance of a varying number of subradial tentacles.

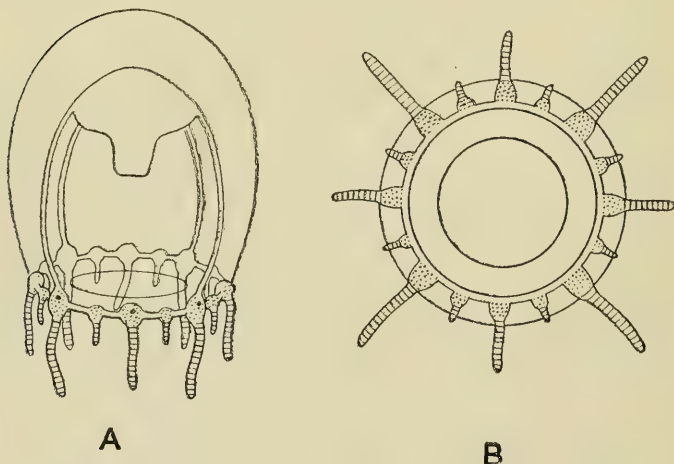
In such medusæ it is obvious that the number of secondary tentacles is correlated with the size of the individuals, the older and larger medusæ possessing a greater number of these structures than the smaller and younger ones. In *Merisia* we are certainly

Text-fig. 223.



Medusa bearing four interradial tentacles in addition to the four perradial ones at the extremities of the radial canals. In this and in the three following text-figures A represents the medusa as seen in a side view, B its oral aspect.

Text-fig. 224.



Medusa with four interradial and eight adradial tentacles in addition to the four primary ones.

not dealing with a phenomenon of this kind, for the larger and more mature medusæ are, with rare exceptions, unprovided with secondary tentacles. In order to show this point more clearly, I divided the 400 individuals which I examined into two

groups:—(i.) including medusæ with an umbrella-diameter measuring between $\frac{1}{2}$ and 2 mm., and (ii.) with a diameter measuring from $2\frac{1}{2}$ mm upwards.

Group (i.) contained 278 individuals of which 39, or about 14 %, possessed supernumerary tentacles between the four primary ones, whereas of the 122 larger medusæ belonging to group (ii.) only 5 were provided with such structures.

Sexual dimorphism is known to occur in a few species of medusæ,* but I have assured myself that this is not the case with the specimens I am describing; microscopic examination, by means of sections and whole mounts, showed that all the medusæ of *Marisia* in my collection belonged to the male sex, whether bearing secondary tentacles or not.

It must be obvious from the above account that the kind of variation I have just described is of a nature totally different from that treated of in the first section of this note. We are certainly not dealing with a case of ordinary meristic variation, and the only conclusion I can arrive at is that these multitentacular medusæ form a distinct variety which has arisen as a mutation from the normal form: it will be interesting to discover whether this variety will maintain itself in Lake Qurun.

Altogether, forty-six † multitentacular specimens have been examined by me; it was found that the number of secondary tentacles varied considerably. 10 individuals possessed four interradial tentacles as well as the four primary perradial ones (text-fig. 223); 28 had twelve secondary tentacles, four interradial and eight adradial (text-fig. 224); and 3 possessed subradial tentacles in addition to these, the medusa illustrated in text-fig. 225 (p. 1052) having as many as eight of these structures, two in each quadrant, situated between the interradial and adradial tentacles.

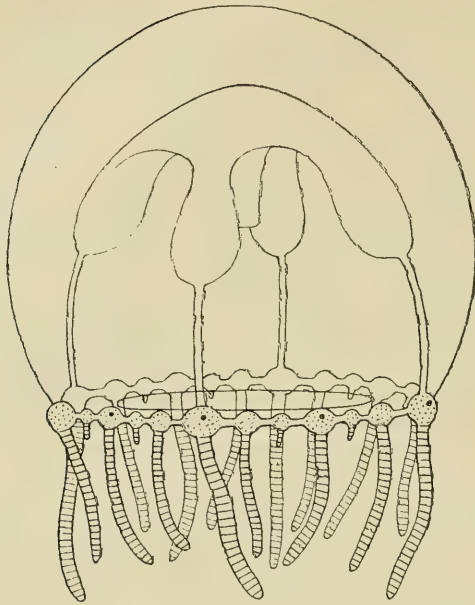
The sketches referred to above, although considerably enlarged, are drawn to scale; they exhibit the fact that this variety of *Marisia lyonsi* follows the general rule for multitentacular medusæ, in that the number of secondary tentacles increases with the size and age of the individuals. The sequence of the development of the secondary tentacles is also quite normal in the specimens just described.

Although the majority of the multitentacular specimens of *Marisia* exhibited a perfect radial symmetry and developed their secondary tentacles in a perfectly normal order, a few medusæ proved abnormal in this respect and showed marked asymmetry. One specimen had a single interradial tentacle developed between two perradial ones, whilst another bore interradial and adradial tentacles also in a single quadrant only. Again, two medusæ had these organs developed in two of the quadrants (text-fig. 226), and a third had secondary tentacles in

* E. g. *Stomatoca dinema* Agassiz, and *Orchistoma pileus* Lesson: see Mayer (10) pp. 111 and 219.

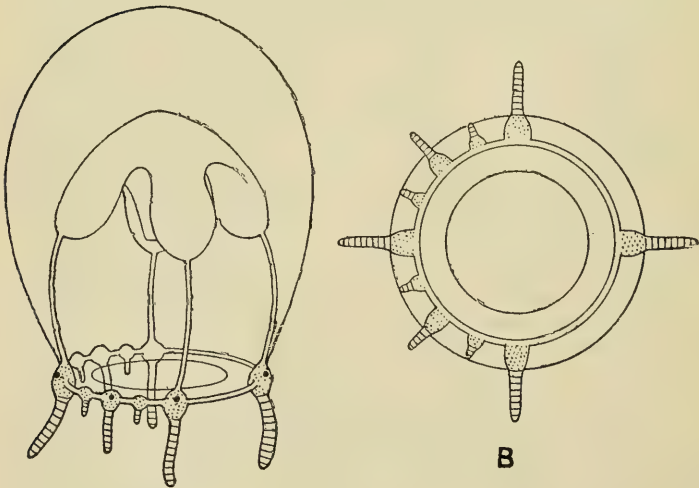
† Two of these specimens were not included in the Table on p. 1049.

Text-fig. 225.



Multitentacular medusa with twenty secondary tentacles.

Text-fig. 226.

**A****B**

Asymmetrical medusa bearing secondary tentacles in two quadrants only.

three quadrants. This specimen had interradial, adradial and subradial tentacles in two of these, whilst the third quadrant carried only a single adradial one*.

Günther has shown that in *Limnocoñida* [9], tentacles of a particular order are often fully formed in one quadrant before there is any trace of them in the others. Browne also has called attention to the fact that in *Podocoryne carnea* [7] the young medusæ do not always leave the hydroid colony with the same number of tentacles, all have four perradial ones but the number of interradial tentacles varies, some having two or three instead of four, and one specimen he noticed to have a single one only.

I do not think that in the case of the asymmetrical medusæ of *Maerisia* to which I have just referred, we are dealing with any retardation in the development of the tentacles in certain quadrants; some of these individuals were of considerable size and the gonadial diverticula well developed (*cf.* text-fig. 226), yet certain quadrants showed no signs whatsoever of secondary tentacles, although other quadrants possessed tentacles of the third or even fourth order.

These five asymmetrical medusæ clearly indicate that each quadrant is capable of forming secondary tentacles quite independently of the other quadrants of the bell. That this can occur in a radially symmetrical animal is distinctly stated by Bateson [15] who remarks, that in radial series "as in Linear Series, Variation, whether Meristic or Substantive, may take place either in single segments (quadrants, sixths, etc.), or simultaneously in all the segments of the body." This statement was based on observations made on two medusæ, *Clavatella* (*Eleutheria*) *prolifera* and *Aurelia aurita*.

Clavatella is a medusa which normally bears a single ocellus at the base of each of its six tentacles. Claparède [16] has called attention to the fact that these ocelli are sometimes doubled; this duplicity may occur at the base of a single tentacle or occasionally at the base of each tentacle instead of one.

Bateson also quotes the observations made by Romanes [4, 5] on *Aurelia aurita*. In this form, in addition to changes symmetrically carried out in the whole disc, one or more quadrants may vary independently. Thus one specimen is figured in which two quadrants are normal (*i.e.*, each possesses one generative organ and a set of radial canals) but the other half-disc is divided into three. Similarly a particular quadrant may possess two sets of organs or even three, the other three quadrants being normal or nearly so.

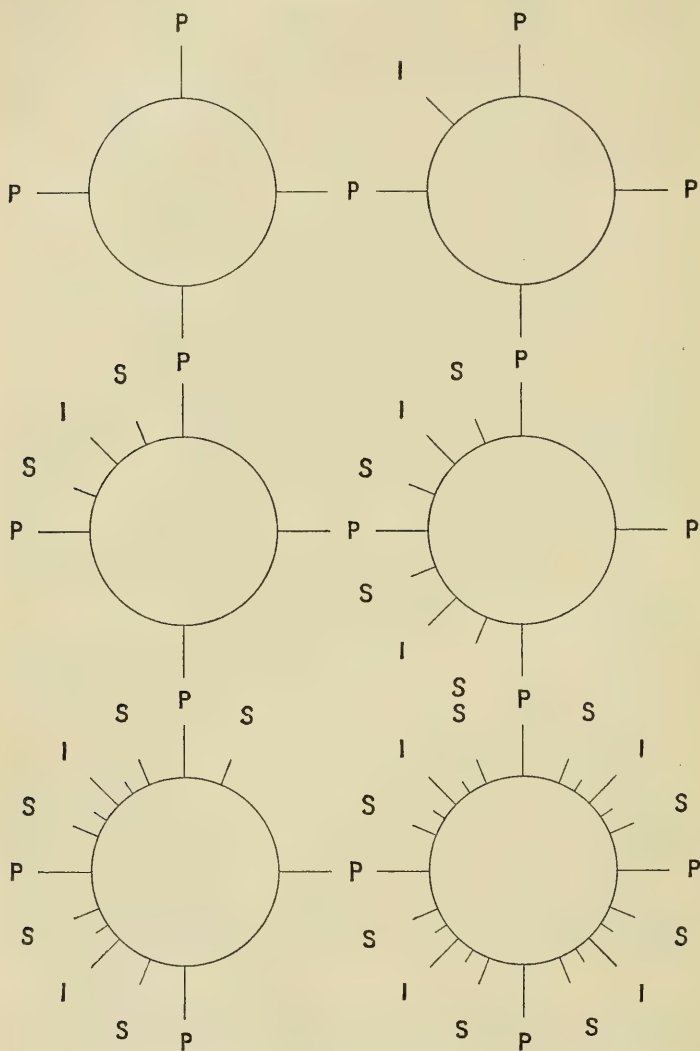
In addition to the forms described above, three other medusæ showed abnormalities of a quite different type, which, although known to occur in other genera, I consider worth recording.

In the first of these specimens, which was normal as regards

* This specimen is one of those not included in the Table published in my original paper on *Maerisia lyonsi*.

the number of its tentacles, one of the latter organs was branched in such a way as to present the appearance of a smaller tentacle growing out laterally from a perradial one.

Text-fig. 227.



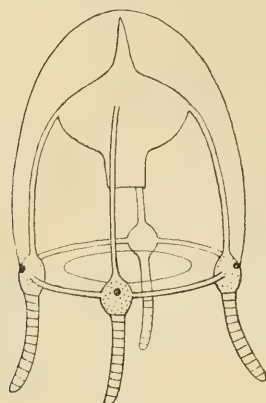
Diagrams showing the arrangement of tentacles in a normal and five abnormal medusæ of *Merisia lyonsi*.

P. Perradial tentacle. I. Interradial tentacle. S. Secondary tentacle in an adradial position. The subradial tentacles are not lettered.

Such branched or bifurcated tentacles have been recorded previously by several authors, among whom Agassiz and Woodworth [2] have described the phenomenon in medusæ of *Obelia* (*Eucope*), and Hargitt [8] came across a similarly abnormal specimen of *Gonionemus*.

It seems highly probable that such abnormalities are not congenital, these bifurcated tentacles having no doubt arisen as the result of injury to normal ones.

Text-fig. 228.



Abnormal medusa in which the apical canal is retained.

The abnormality presented by the other two medusæ is of greater systematic interest: each of these specimens possesses a well-developed apical canal which projects from the base of the stomach into the jelly at the summit of the umbrella (text-fig. 228). This peculiarity is obviously due to the fact that these specimens have retained the greater part of the canal which in early life connected the cavity of the medusa-bud with that of the parent-hyroid.

The presence of an apical canal was at one time considered to be a specific character of some importance, but recent systematists* have shown that such a canal occurs frequently as an individual variation in many species which normally lose this organ in the adult stage.

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* Cf. Mayer's remarks on *Sarsia prolifera*, and other species of this genus (10).

† This list includes only those memoirs actually referred to in the text of this paper; for a more complete bibliography I must refer the reader to Dr. Mayer's recently published monograph (10).

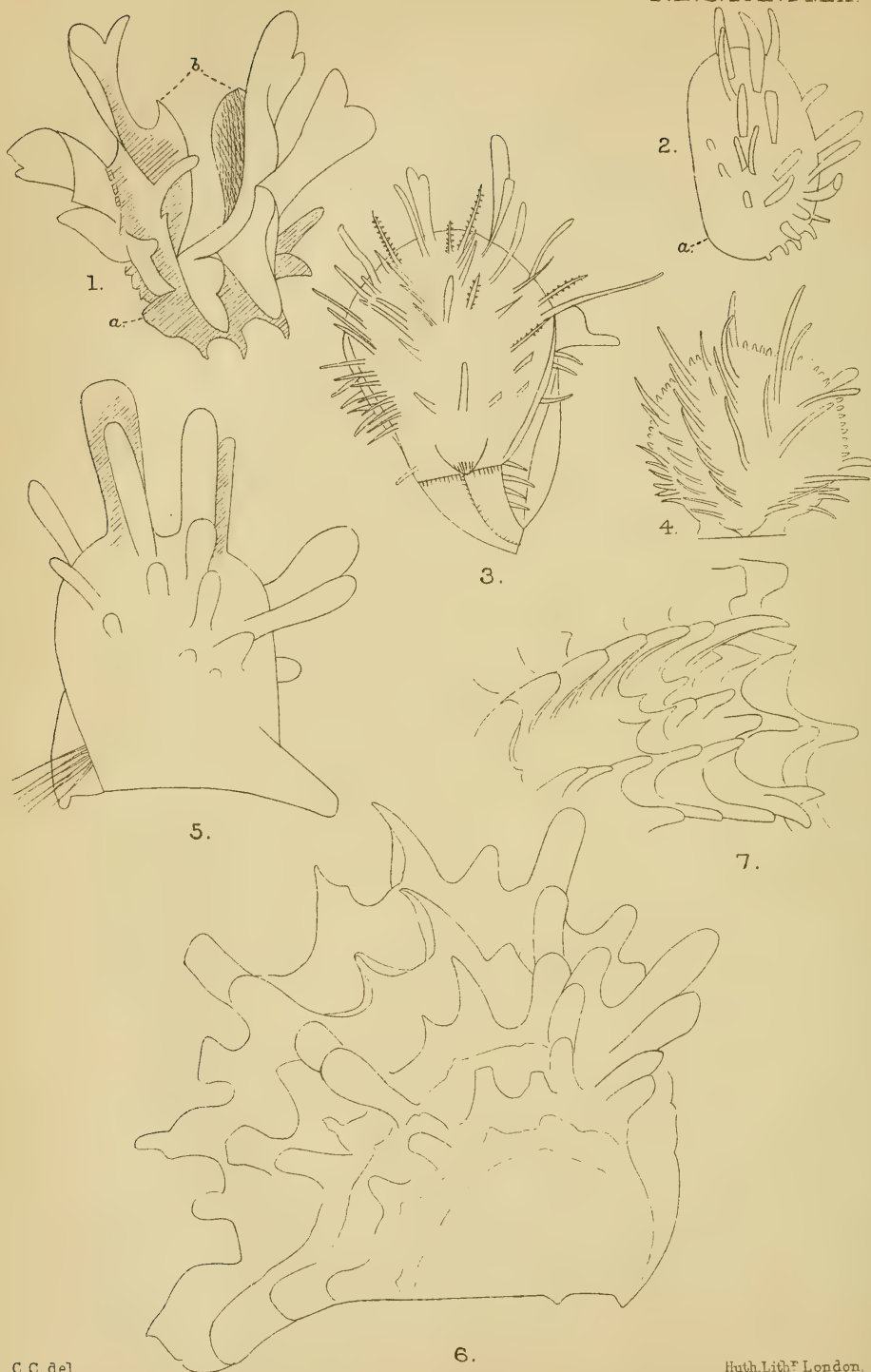
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EXPLANATION OF PLATE LIX.

Fig. 1. A transverse section through a normal adult medusa of *Mærisia lyonsi*. The section shows the four radial canals and gonadal diverticula, as well as the four endodermal ridges in the manubrium.
end., endodermal ridge. *g.p.*, gonadal diverticulum. *lam.*, endodermal lamella. *man.*, manubrium. *r.c.*, radial canal.

Fig. 2. A similar section through a pentamerous specimen of the same species. Note that although five radial canals and gonadal diverticula are well developed, only four endodermal ridges occur in the manubrium. Cf. p. 1048.

Lettering as in fig. 1.



48. The Marginal Processes of Lamellibranch Shells.

By CYRIL CROSSLAND, F.Z.S.

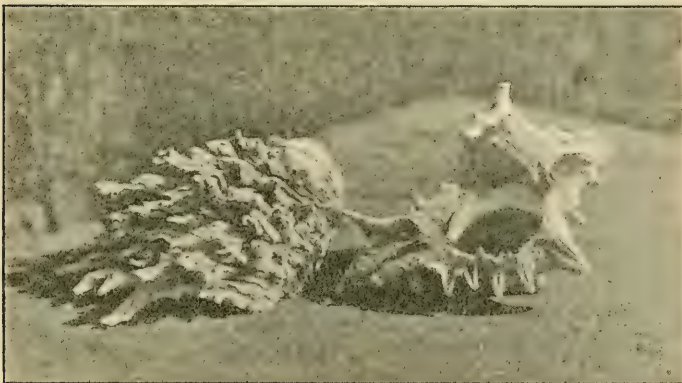
[Received May 27, 1911 : Read June 27, 1911.]

(Plate LX.* and Text-figs. 229 & 230.)

The existence of the ornamental projections on the surface of so many lamellibranch shells is rather puzzling to the student of Bionomics. Especially to one interested in the rate of growth of mother-of-pearl shell does their formation seem a sad waste of shell-making energy.

The drawings given show examples of these processes in young and adult shells. Inspection reveals one striking fact, that the proportion of shell-building energy thus expended is very much greater in quite young shells than in the mature ones of several species. Compare, for example, the figure of a specimen of *Margaritifera*

Text-fig. 229.

Shells of *Murex ramosus* and upper valve of adult *Chama foliata*.

Half natural size.

The illustration will serve for identification of these common shells by non-conchological readers.

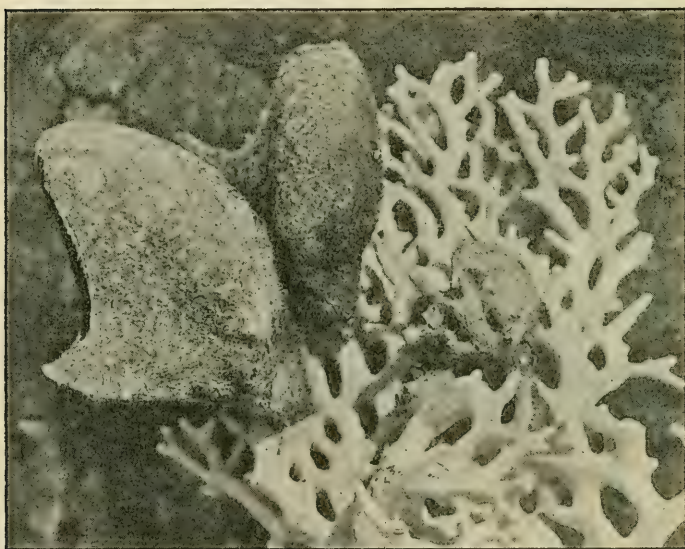
margaritifera (the large mother-of-pearl oyster) seven months old and that of the portion of the margin of one $5\frac{1}{2}$ years old, also the young of *Chama foliata* and *Chama* sp. of about the same age with the adult shells, and it is seen that relatively the processes are gigantic in young shells (Pl. LX. and text-fig. 229). They must have their use, or they could not be so greatly developed at this, the second, critical stage of the bivalve's existence † (the first

* For explanation of the Plate see p. 1061.

† Utility is suggested also by the fact that such processes cannot be regarded as ancestral features such as in some other cases are more prominent in the young of a species.

critical stage is that during which the free-swimming larva must attach itself to a suitable substratum or perish). At this second stage the Aviculidæ at least are in the most active state they attain to, and most other normally sessile lamellibranchs have well-developed and actively used feet. *Tridacna gigas* is very active at this stage, to mention a form probably not often seen when so young, and particularly well fixed down when adult. Their future life depends upon their success in crawling into the position adapted to the special needs of their species. Also they are now large enough to be attractive as food to fishes and crabs, but not strong enough to resist claws and pincers. In the case of *M. margaritifera*, among other species, the animal has little to fear after it is one year old, being then too strong-shelled for ordinary fishes and crabs.

Text-fig. 230.



Two specimens of *Avicula zebra* attached to *Millepora alcicornis*, and in the centre of the latter a specimen of another genus of the Aviculidæ which is more common on corals. Another species of *Avicula* is found on "black coral," *Antipatharia*. Half natural size.

Balistes flavimarginatus and *B. viridescens*, the largest of a genus of shell-eating fish, are fairly frequently found here* in the Red Sea, and occasionally break up "pearl" oysters two or three years old, but those dissected were found to have preferred smaller and weaker-shelled species. The big Rays are not common, and

* Dongonab, Port Sudan.

I have not certainly traced any damage to them. *Tridacna*, *Spondylus*, and *Chama* similarly have every chance of reaching old age once the younger stages are passed, and the majority of specimens found are thick and heavy; on the other hand, *Margaritifera vulgaris* (the Ceylon pearl-oyster), *Ostrea* sp.?, and *Avicula zebra* of a year or two old are common, but above this age are scarcely ever met with in the Red Sea. In the only fishery for *Margaritifera vulgaris* which I have seen here, shells two or three years old, and small for that age, were being obtained in comparatively insignificant numbers.

That energy so valuable elsewhere should be wasted upon unnecessary appendages is also negatived by the consideration that in this class, as elsewhere in nature, the struggle for existence is severe, demanding the nicest adaptations to environment. This is shown by the existence in this one bay of three distinct species of *Margaritifera*, anatomically scarcely distinguishable, apparently living together in the same habitat and obtaining food in exactly the same way. Only after careful study does it begin to be seen what delicate adaptations to special environments keep the three species distinct, each in its own niche in the world.

Observations of the relations between living examples of the following species and their common foe, *Murex ramosus* (text-fig. 229), shows that these ornamental processes have a simple and essential use to their possessor; indeed, without them they would fall such easy victims to predatory Prosobranchs that those species not otherwise protected must become extinct.

The following species living in exactly the same surroundings, in the same artificial way, were observed, and their mortality from attacks by *Murex* noted:—

<i>Ostrea</i> sp. ?	No spinous processes.	Decimated.
<i>Avicula zebra</i> ...	" "	" "
<i>Margaritifera mauritii</i> .	Processes small and weak.	Killed in large numbers.
<i>Margaritifera vulgaris</i> .	Processes small, except in quite young shells.	Kept alive by frequent removal of <i>Murex</i> , otherwise numbers perished.
<i>Margaritifera margaritifera</i> .	Processes large and strong, remain well developed to at least 6 years old.	Attacked only exceptionally.

We see that in these five species the liability to attack by *Murex* (and probably by other prosobranchs, the behaviour of which I have not observed) is just in proportion to the development of spines. The cases of attack upon *M. margaritifera* which I have seen corroborated, occurred only in stunted shells in which these processes were ill-developed.

In the *Aviculidæ* at least the processes are made from the two

outer shell-layers only, and as both of these are weak and horny, so are the processes. These consequently get worn off the older parts of the shell, and as increase in diameter becomes slow so does the development of these processes* and in full-grown shells practically ceases altogether.

It is obviously an advantage to the "oyster" to grow up rapidly, and form a shell large enough to resist teeth and pincers as quickly as possible. *Margaritifera vulgaris* succeeds excellently in this, attaining nearly its full size in a year; but it does this at the expense of the sooner losing its shell-processes and so being open to attack from *Murex*, and doubtless other predatory prosobranchs.

In *M. margaritifera* also growth is extremely rapid during the first year, and at the end of it the shell is strong enough to resist such crabs and ordinary fishes as infest this bay; but after the second year it is slow, a shell six years old being far from full-sized. Consequently the formation of marginal processes continues later, and with it partial immunity from attack by *Murex*. Sexual maturity is reached by all these species alike in the second year.

From the result of my experiments recorded above, one wonders how the first three species can possibly survive in Nature. The explanation is very simple: they choose a habitat out of reach of their foe. *Ostrea* sp.? and *Margaritifera mauritii*† inhabit crannies among other shells‡ or in stones, too narrow for *Murex* to enter; while *Avicula zebra*, like other species of the same genus and a few other genera of the same family, possesses a foot that fears not the stings of corals, nor even those of *Millepora*, and so attains a habitat inaccessible to all others (text-fig. 230, p. 1058).

Avicula zebra is very common on *Millepora alcicornis* in the Red Sea; another advantage of this habitat is support above the sea-bottom, clear of all obstructions to its respiratory circulation, which latter is of greater value than would be supposed.

Given protection from enemies, and from being smothered in mud, all these species will flourish wherever the experimenter likes to place them, these two considerations being all that causes the restriction of their habitats in nature.

* Only in a general sense is this true. In two specimens of *M. margaritifera* of about the same age, viz. two years, one has added to its diameter much less than has the other, owing to difference of conditions in which they grew; but this has not hindered development of processes, which are merely nearer together in the slower-growing specimens. It is when slow growth is due to age that the formation of processes becomes imperfect.

† This species, when over a year old, forms a postero-ventral non-nacreous addition to the shell, similar to, but smaller than, that found in many other *Aviculidae*, and which reaches extreme development in *Malleus*. In all, the addition is an adaptation to enable the animal to inhabit narrow crevices, and its function is similar to that of the siphons of those lamellibranchs which live buried in sand, or in burrows.

‡ *E.g.*, on the under sides of large specimens of mother-of-pearl shell brought in by the divers.

The way in which these processes protect the lamellibranch has yet to be explained. From actual and repeated observation one would expect that the prosobranch could extend its proboscis for a short distance and insert it amongst the processes, which are not generally very near together, and so drill its hole without trouble. It is, however, necessary for the *Murex* to obtain a very firm hold with its foot before it can operate its drill, and one finds cases where a distinct impression of the foot has been made among the growths on the shell before any damage has been done at all. The point of special interest to the naturalist as well as to the practical pearl-fisher, is that one cannot estimate the damage done by *Murex* by counting how many of a lot of dead shells have the characteristic hole drilled through them. In more than three cases out of four no hole is drilled at all, *Murex* having found an easier way. It finds the flexible edge of the shell, then by contractions of its foot breaks a piece away. The mucus of the foot-glands is then poured out in quantities, and this has some poisonous effect, as the animal, while still untouched, ceases to respond to the stimuli which ordinarily cause a smart closure of the shell. The abundant flesh of this species is all devoured before putrefaction sets in.

EXPLANATION OF PLATE LX.

Except for figs. 6 and 7, specimens of about the same age have been drawn to the same scale, the age being something under six months, the magnification $\times 3$.

- Fig. 1. *Chama foliata*. A dead shell, widely gaping, seen from above, *i.e.* from anterior end. *a*, hinge; *b*, ventral edges of shell.
The shell-processes are seen to be about half the diameter of the shell in length. At this age they and the shell are brilliantly coloured with dark red bands on a light yellow ground. In the adult shell the processes remain conspicuous (hence the specific name), but in the young they are out of all proportion to the size of the animal that forms them.
- Fig. 2. Upper valve only of *Chama* sp.? Shell red, processes white. In adult shells processes quite inconspicuous, generally absent. Animal then protected by the extreme solidity of its shell.
- Fig. 3. *Spondylus* sp.? A specimen which is beginning to take the adult shape and to form the characteristic strong spatulate processes instead of the brittle needle-like serrated processes characteristic of the younger stages. These serrulations are shown in only a few instances in the figure.
- Fig. 4. A rather younger specimen of the same, with long slender processes only and edge of shell serrated. Upper valve only drawn.
- Fig. 5. *Margaritifera margaritifera*. A specimen 12 mm. across shell, with processes 7 mm. long. Probably three months old; younger specimens than this have perfectly smooth shells like the umbonal region of the present specimen.
- Fig. 6. The same, $\times 2$, aged about 7 months. Showing development of processes characteristic of the first two or three years' growth. Some of the radial rows of processes are thick and spatulate; others, which are thinner, shrivel and become pointed, as in the figure, on drying.
- Fig. 7. The same. Part of the edge of a three-year old shell which has grown slowly. Shells more rapidly developed are distinguished by the wider spacing of the processes.

49. Warning Coloration in a Nudibranch Mollusc and in a Chameleon. By CYRIL CROSSLAND, F.Z.S.

[Received June 12, 1911; Read June 27, 1911.]

I. WARNING COLORATION IN *CHROMODORIS*.

Since the discovery of warning coloration there has been a tendency to attribute protective value to displays of brilliant tints which further observation has rendered doubtful, and the instances in which actual protection has been experimentally proved are not so numerous but that one more has some value.

The Chromodorids are, as their name implies, a family of Nudibranchs characterised by the development of colour shown by all its members. Having collected a large number during the past ten years, I may say that none of the family has been wanting in this characteristic, except perhaps *Casella atromarginata*, which, though handsomely, is not brilliantly, tinted. In this I merely corroborate the general experience of marine collectors. Besides this universality of colour the family is well defined structurally; indeed for the class the structure is remarkably uniform. The usual depressed form of body, more or less ample margin, broad foot, and feathery, usually tripinnate gills, are, in the more typical Chromodorids, replaced by the opposite characters. A narrow foot underlies a high body, the mantle is a mere shelf along the top of its vertical sides, and the gills are simply pinnate*. Internally the stomach is entirely embedded in the liver.

There is a smaller section of the family in which these characters are less marked, the body having a wider mantle; in some species a few of the gills are branched and the stomach is partly free from the liver, thus indicating a connection with the ordinary forms.

Otherwise structure is so uniform throughout the group, that without detailed description of the colours of the living animal identification of the species is impossible. Even with this description in full, determination of species is difficult, variation being very considerable so that, *e. g.*, what one observer sees as black bands on a white ground is to another white lines on a black body†.

* Are these simply-pinnate gills the primitive form of Nudibranch gill, a modification of the prosobranch ctenidium? The highly specialised Chromodorids supply the answer, since it is the less specialised members of the family that have the more complex gills. A detailed study of the Chromodorid gill would show that its structure is more complex than the term "simply pinnate" leads one to suppose, and possibly would show details of higher organisation than do the tripinnate feathery gills of ordinary Dorids. In the development of these gills from an originally irregular vascular flap of skin, the tripinnate arrangement would be the earlier stage to be reached.

† *Chromodoris quadricolor* Eliot, Journ. Linn. Soc., Zool. xxxi. Nov. 1908, p. 107 = *C. elizabethina*, P. Z. S. 1904, p. 392, Pl. xxiv. fig. 4. Some other Chromodorids are here figured including *C. nigrostriata*, a variety of the *C. diardi* referred to later in this paper and a good example of the variation now discussed.

The family is therefore probably monophyletic (so far as any family can be), and it would seem that the power of colour production is a single character, which, in a few of the cases in which it has arisen, was associated with distastefulness or other protective quality, and so, possessing a great survival value, led to the foundation of the family. What colour or pattern might be produced selection cared not, so long as it were conspicuous in the eyes of nudibranch enemies, and duly correlated with inedibility*.

Hence the multitude of patterns and colours found in this one class, and the variation above mentioned. Possibly one colour is much the same as another in the biochemistry of the animal, though so different to the human eye†.

The survival value of the devices is evident from the abundance of species in tropical waters. In collections, while species are numerous, individuals are usually rare, but the peculiar habits of many nudibranchs, which suddenly appear in local swarms and shortly disappear again completely, show that as in, *e. g.*, the case of the Sharks of St. Andrews Bay‡, which were not known to exist there until new fishing methods were introduced, the proportions in which species occur in collections are not at all those in which they live in the sea. Of the Chromodorids I remember particularly *C. annulata*, *C. sykesi*, *C. hilaris*, and *Ceratosoma cornigerum* as occurring for a few days in quite local swarms, then disappearing absolutely; while during the past fortnight a hundred specimens of *C. reticulata* [Pl. LXI. (p. 1068)] could quickly be collected within a few yards of where I write, but to-morrow there may be not one.

The collection would be the more easy in that this species like all Chromodorids crawls about in the open instead of skulking under stones or in crannies after the fashion of most of the class, except of course at low tide when it would otherwise be killed by the sun.

In contrast with this, the general inconspicuousness of most Opisthobranchs culminates in many cases in adaptations which result in resemblance to surroundings so striking and so well in accord with the observed habitat, that there can be no doubt as to protection being afforded by them§.

* Amidst this diversity we find that in all Chromodorids the edge of the mantle is specially coloured. In others the gills and rhinophores are coloured differently from the rest of the body, as in the case of *C. diardii*.

† That the colour of marine animals is often connected with their essential physiology or apparatus of reproduction is indicated by the many cases in which the eggs of a species are deeply coloured with the principal body colours of the parents. This is conspicuously the case with numerous species of Polychaeta and Nudibranchs. The Chromodorid hereafter described under the name of *C. reticulata* lays eggs the colour of the yellow bands on the mantle. The purple band secretes mucus of the same tint, so that probably the purple colour has its physiological use, as well as warning colour value.

‡ McIntosh, W. C., "Notes from the Gatty Marine Laboratory," Ann. Nat. Hist. vol. x. p. 254, 1902.

§ I have never had the fortune to possess a properly stocked aquarium in which experiments on this side of the theory could be undertaken.

Two interesting facts are worth recording of the coloration of several species of Tectibranchs, which besides being close simula-lara of their environment in other respects, each occur in green and brown varieties, simulating green or brown weeds, or at least in one case, the old and young shoots of *Zostera*. Living specimens of these species are not now within my reach or further details might be given, and sketches. The same thing happens in a Scyllaeid*, the brilliant green and the brown forms of which are found near together in Chuaka Bay, Zanzibar, whilst greenish to deep brown varieties occur here (Dongonab) in the Red Sea†. The other point about the coloration of these forms (Scyllaeid and Tectibranchs) is the occurrence in so many species of small brilliant blue spots, sometimes ringed with yellow, the only conspicuous thing about otherwise scarcely visible creatures. These *may* be "recognition marks" but are more likely to be glands‡.

We have then an excellent case for the theory that the brilliant colour of these animals has a protective value. They walk abroad where others must creep and hide.

Distastefulness was proved by trying to feed fish with specimens (mostly *C. reticulata*, twice with *C. diardii*) thrown from the windows of my houseboat. The kitchen refuse, and the shelter afforded from the sun had made the surrounding water populous with fish, and on a calm morning every detail of their movements was clear. The water was shallow, the bottom sandy, with a covering of short "sea grass," the usual habitat of several fish and often of considerable numbers of *Chromodoris reticulata*, more rarely of *C. diardii*.

The Garfish, *Belone* sp., is the only one of these animals with a specialised diet. It is ever on the watch floating near the surface, herding together the shoals of "sardines" (*Engraulis* ? *boelama*),

* *Crosslandia viridis* Eliot, P. Z. S. 1902, pp. 64-68; *C. fusca* Eliot, Journ. Linn. Soc., Zool. xxxi. 1908, p. 90.

† The green Zanzibar specimen was found on *Zostera*, which is less abundant in the Red Sea and from which I have not yet obtained this species.

‡ Other brilliantly coloured Nudibranch families are the Polyceridae and Aeolidae. Of the former I have seen too few specimens to generalise, but one of the most beautiful, the wine-red *Plocamopherus ocellatus*, was merely a lighter tint of the colour of its environment, a deep red polyzoan on which it fed. There is some evidence that it owes part of its colour to its foodstuff.¹ Another, *Trevileyana crocea* ², is a little slug-shaped beast of a brilliant yellow colour. It periodically occurred in great swarms in Chuaka Bay, Zanzibar, in the open, not hiding in any way. The Aeolids are all bright coloured, I believe, and all, or nearly all, gain protection by living amongst hydroid zoophytes, and even can utilise the stinging-thread cells of the latter in their own bodies.

Tritonids often live among zoophytes, in Zanzibar often among fleshy Alcyonaria, and are fairly conspicuously coloured. But *Melibe fimbriata*, a large animal, in colour and in the shape of its cerata and the processes it bears, looks extremely like a fragment of drifting fucus-weed.

¹ Eliot, Sir C., "Marine Biology of the Sudanese Red Sea," Journ. Linn. Soc. xxxi. Nov. 1908, p. 104.

² Eliot, Sir C., "Nudibranchs from East Africa and Zanzibar," P. Z. S. 1904, vol. ii. p. 87.

occasionally making dashes into the shallow water and carrying off stragglers. Yet even *Belone* dashes up for any bait thrown into the water, though the portions that sink below the surface are left to the numerous bottom feeders. Of these we have *Chrysophrys bifasciata*, *Pimelepturus cinerescens*, and two other species which I have not identified, and they will eat, or have become accustomed to eating, almost anything, including shelled specimens of *Margaritifera vulgaris* which had been kept in formalin for three weeks, and the guts of *Balistes flavimarginatus* and *B. viridescens* which had been in the same preservative overnight. *Pimelepturus* eats the fresh viscera of its own species, or the pure white cooked flesh of *Caranx* sp. equally readily. But none of these five fishes will eat either of these two species of *Chromodoris*; attracted by the splash they dashed up to them as to any other bait, but one fish after another, of each species, as the nudibranch sank, at once turned away after just touching it. Examples of *Chrysophrys* took the animals into their mouths, but at once dropped them undamaged.

The behaviour of *Pimelepturus* was particularly interesting. If a specimen of *C. reticulata*, which is white underneath (but for a few purple spots under the edge of the mantle), fell on the sand wrong side up, the fish would at once attempt to take it. If, however, the slug fell right side up, so displaying its gorgeous mantle, *Pimelepturus*, swimming over it a few inches away, took no more notice of it than of a stone.

What actually prevented these numerous fishes, of five distinct species, from swallowing the *Chromodorids*? One can hardly believe that a living slug could have a flavour more powerful than that of formalin! Moreover, these two species have no odour sensible to human organs, as have so many marine organisms, including the Chromodorid *Ceratosoma cornigerum*, and the Tritonid *Melibe jimbriata*. The behaviour of these fishes, which had for some weeks been feeding upon all kinds of kitchen refuse, and especially the fact that when presenting an *un-usual* appearance *Chromodoris* momentarily attracted them, disposes of the objection that they merely refused to eat an object which was strange to them. Indeed, the natural circumstances of the case make it impossible that *C. reticulata* should be unfamiliar to any of these fishes except *Belone*.

But that this objection is a weighty one and in all supposititious cases of protective coloration must be carefully considered, the following examples will show.

The camels of the southern part of the Red Sea Province get desert grazing all the year round, and are not fed upon "dūra" corn (*Sorghum*) in the summer. The consequence is that a southern camel has actually to be taught with much patience (for he deserves all that Kipling said about him) to eat corn. The feast may be spread before him, but eat it he will not, until his owner, seizing him by the nostrils, pours the corn into his mouth with the other hand, spite of his groaning protests. Indeed some

camels never get beyond this stage, and however hungry hold their heads in the air above the pile of corn, crying like spoiled children until the owner comes to feed them.

Contrast with this the behaviour of my two tame gazelles. From six weeks old to maturity they fed on milk, corn, and occasionally native leguminous plants. When fully adult they were introduced to bread, sweet biscuits, sugar, green corn-stalks, and the leaves of *Acacia tortilis*, all of which they ate readily without the stimulus of hunger. I once tried to feed a sick camel on stale bread, by way of invalid diet. It was impossible.

Another case is rather like that of the pigeons that starved rather than eat a strange seed. I tried to change the feeding place of my fowls by throwing their corn a yard or two to one side of the usual place in the direction of the new one. When called the fowls rushed up, stopped dead at the accustomed spot, and nothing would make them move a foot beyond it. We can pair the fowls with the opposite case, as we did the camels with the gazelles. The land crab *Ocypode* makes its burrows a little above high-water mark and never more than a yard or two higher up. But where the camels and fowls were regularly fed, the ground is full of the holes of these crabs ten or twenty yards above their usual habitat. Also, instead of confining themselves to their accustomed diet of dead fish, these lively crabs are ready for any experiment, from sweet biscuits to handkerchiefs, and some must now be living on camel dung and corn.

There are no oysters in Jerusalem, and consequently a native of that city cannot be persuaded to try one. He has no religious prejudice, or other dislike, but "No, I do not know them" is his sufficient reason.

II. WARNING COLORATION IN A CHAMELEON.

I have not seen the fact recorded that the Chameleon (*Chamæleon* sp.) can change its colour so quickly as to frighten a dog. While staying in Zanzibar my host's fox terrier showed hostile interest in a chameleon someone had brought into the house. The chameleon invariably tried to run away when attacked, but those who know the species can imagine the ludicrous ineffectiveness of a chameleon's flight. In a few seconds the impossibility of escape seemed to reach the animal's brain, when it at once turned round, opened its great pink mouth in the face of the advancing foe, at the same time rapidly changing colour, becoming almost black. This ruse succeeded every time, the dog turning off at once. Among the natural leafy surroundings of a chameleon the startling effect of its sudden change of colour would be much greater. Imagine a dog or cat nosing about suspicious of the presence of a live animal, but unable to see anything. Until almost touching him the chameleon sits close, secure in his mantle of invisibility. Then suddenly,

when the dog's nose is within six inches of him, the sudden change from invisibility to the conspicuous black body and great red mouth! I think many human beings would be startled, and in fact the natives of Zanzibar hold the chameleon in horror, and cannot be persuaded that its bite is not deadly. I tried the effect upon some of them on my way home. The ordinary native will show great caution, but no panic, when a chameleon is handled by a white man. I presented my specimen *unexpectedly* to several parties I met on the road, thus:—

On approaching, "Good morning," which was quietly responded to.

Just after passing, "See what a nice creature is walking on my back." Shrieks, and a stampede of fifty yards.

The specimen showed the ordinary light and irritation reactions which have been frequently recorded.

50. Chromodorids from the Red Sea, collected and figured by Mr. Cyril Crossland. By Sir CHARLES ELIOT, K.C.M.G., C.B., F.Z.S.

[Received June 12, 1911 : Read June 27, 1911.]

(Plate LXI. *)

The present paper is a pendant to the one preceding it, and gives some account of three species of *Chromodoris* from the Red Sea which, though not new, are worth notice as being either varieties of known species or forms hitherto imperfectly described. The matter which it contains is mainly due to Mr. Crossland, and I have contributed merely the identification of the species and a few notes on their internal anatomy. The first species, *Chr. reticulata*, is the one on which Mr. Crossland made his interesting observations regarding the warning coloration of the genus. My own experience does not entirely support his statement that Chromodorids do not hide under stones but show themselves in the open. I have often found them (as well as *Trevelyana crocea*) under stones on tropical beaches, where their vivid colours harmonize wonderfully with the ascidians and sponges found in the same locality, so that the nudibranch which when isolated is conspicuous, is almost invisible at home. But, as Mr. Crossland points out, many species are known to arrive on the shore in considerable bands for the spawning season, and perhaps all do so. At this critical period, at all events, warning coloration must be useful to them.

The following notes on three Red Sea species indicate that there is considerable variation not only in colour but in the details of the buccal parts. In what appears to be the same species, the denticulation of the teeth and the shape of the elements in the labial armature may vary, and thickenings of the rhachis, amounting to rudimentary central teeth, may be present or absent.

CHROMODORIS RETICULATA Pease, var. (Pl. LXI. figs. 1-3.)

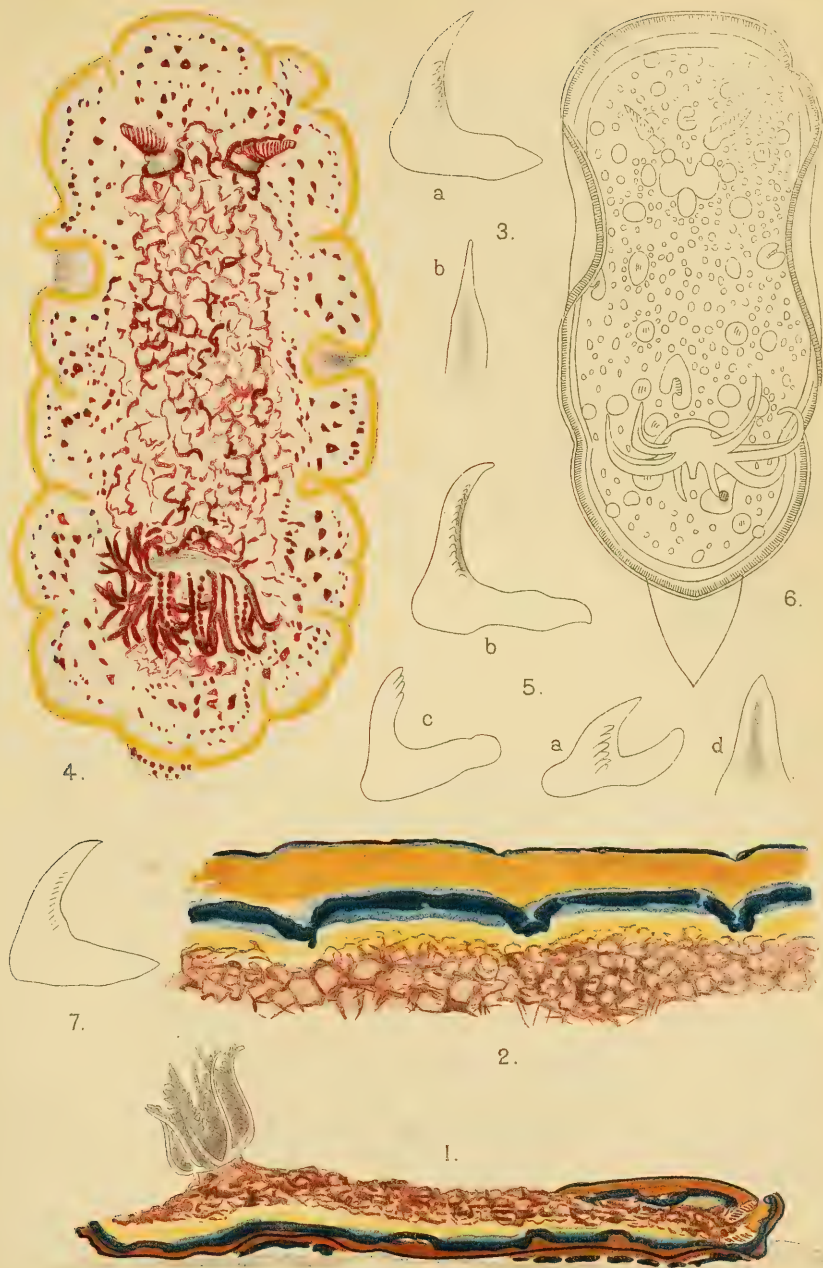
See Bergh, "Neue Nacktschnecken etc." No. iv., Jour. Mus. Godeffroy, Heft xiv. p. 9 ff.; and Eliot, P. Z. S. 1904, pp. 386-7.

Mr. Crossland's notes on the living animal are as follows:—

"This species is of the soft flat kind. Rhinophores with rather high cups. Gills 9, hinder ones short, set in a simple circle open behind, unbranched, simply pinnate, motionless. Foot projects slightly behind the mantle. Mantle-edge slightly or distinctly wavy, according to the extension of the animal.

"*Colour*. Greater part of the back a fine network of chocolate-brown on a grey-white ground; laterally both network and

* For explanation of the Plate see p. 1072.



E. Wilson, Cambridge.

ground-colour become yellow, forming an ill-defined yellow band which passes into white. Round the mantle-edge are two deep coloured bands, the outer orange-yellow, the inner deep violet. There is a faint line of purple round the extreme edge of the orange-yellow border. Foot and whole under side pure white except that colours of mantle-edge are repeated on the under side. The inner border of violet on upper surface is thickened in places, and these points are those where the bending of the mantle-edge is marked when the animal is half contracted.

"Rhinophores brown with clear white lines along the perfoliations; gills grey with white lines on the edge of the folia and specks elsewhere.

"One specimen measured 5.0 cm. \times 1.6 cm. when fully extended."

Four specimens which have assumed a uniform dull plum-colour, no markings being visible. In most other respects they agree with Mr. Crossland's description of the living animal, but whereas he gives the gills as only 9, I find that they vary from 12 to 18. It often happens that in Chromodorids with many gills, the smaller plumes are not protruded from the pocket and thus escape notice.

The labial armature consists of bent rods, but they are not bifid as in other specimens which I have examined. In two specimens the formula of the radula was $63 \times 50.0.50$ and $65 \times 68.0.68$ in the widest rows. The rhachis, as in the specimens described by me from East Africa, bears triangular thickenings, in which the base is not clearly defined. The first laterals are as usual in the genus, low, flattened, and bearing 4 denticles on either side. The remaining laterals are rather stout, hamate, and bear 6-8 distinct denticles. The outermost laterals are lower and bear two or three denticles on the apex only.

These specimens are referable to *Chr. reticulata*, but seem to be a distinct variety characterized by (1) the shape of the rods in the labial armature, which are not bifid at the tips; (2) the presence of thickenings on the rhachis of the radula; (3) a violet border to the mantle. As will be seen from my previous descriptions of the species, the coloration is variable.

CHROMODORIS TINCTORIA Rüppell & Leuckart. (Pl. LXI. figs. 4 & 5.)

Rüppell & Leuckart, Neue Wirbellose Thiere des Rothen Meeres, p. 32.


A single specimen described by Mr. Crossland from the life as follows:—

"*Chromodorid* in shallow water on *Zostera* growing in sand.

"Length 98.5 mm. Breadth of mantle 46 mm.

"Body and foot are narrow, mantle more than ordinarily wide, margin thrown into folds and very mobile.

"Whole animal soft and smooth-skinned, but there are soft warts on the back, about $\frac{1}{8}$ inch high and broad. Gills in a row

shaped  on a raised base, 18 in number, generally simple but some are forked; one quite arborescent, bipinnate. Pinnules rudimentary. The gills are completely retractile and gill-pocket can close over them. Rhinophores fully extended; numerous fine white lines on deep crimson ground, otherwise perfoliations hard to see; completely retractile. Head distinct, with prominent tentacles.

"General colour greyish white, but this is plentifully sprinkled with clear white opaque marks, so that general appearance is white. Over the body this is covered with a delicate network of crimson, the mantle being sprinkled with clear spots of the same colour. Edge of mantle bordered with a thin clear line of bright orange-yellow. A broad crimson line runs up each angle of each gill rhachis."

Mr. Crossland adds in a letter: "The margin is much more ample than in other species known to me. I have never seen one before in which the undulations are so deep or keep in such constant motion."

Rüppell and Leuckart's diagnosis is "Colore lacteo, pallii margine sulfureo-limbato: dorso venis punctisque sanguineis notato: branchiis 19 circiter, pinnatis." They also say that the branchiæ are "pyramiden-förmig," which corresponds to Mr. Crossland's observation that the pinnules are rudimentary. The coloration is sufficiently distinct to make the identity of this animal with Rüppell and Leuckart's *Doris tinctoria* certain.

The preserved specimen is somewhat distorted but the breadth of the mantle margin is still noticeable, and the shape is not that of an ordinary *Chromodoris*. The internal characters appear to be those usual in the genus. Though the outer surface of the liver is purple wherever it is covered by the hermaphrodite gland, yet the organ itself is of a deep black and leaves a strong stain.

The labial armature consists of two dark purple plates.

The rhachis bears thickenings much as in *Chr. reticulata*, and the radula is of a type common in the genus. The inner laterals are low and flattened, the innermost bear 3-4 denticles on either side; the rest are denticulate on the outer side only and the number of denticles rises gradually from 5 (on the second and third laterals) to 15 or more. The teeth at the same time become tall and elegant in shape. There are about 60 laterals in all. The marginals are denticulate on the tip only but are not degraded to mere plates.

CHROMODORIS INOPINATA (?) Bergh. (Plate LXI. figs. 6 & 7.)

Bergh, Siboga, pp. 157-159.

A single specimen described by Mr. Crossland from the life as follows:—

"? CHROMODORIS sp.

Shallow water say 3 feet deep, sand and "sea grass," in Dongonab Harbour (March 1911).

" Full length, from edge of mantle in front to tip of foot behind 82 mm., breadth across mantle 40 mm.; these being measured when the mollusc is crawling. Turned over on its back, the body is only 20 mm. wide, mantle remaining much as before; its margin is not only thus ample, but also mobile. It has no permanent undulations.

" Eight gills, simply pinnate and unbranched, the posterior two short, the rest long even in proportion to the body. They are not held stiffly as in so many Chromodorids but wave about in the water with its motion. (I am not sure whether there is any active motion.) Rhinophores straight and sharply pointed; distal ones two-thirds perfoliate. They and gills completely retractile.

" *Colour.* Back appears of a deep red-brown with numerous orange spots, small yet conspicuous to the naked eye. As the orange shows itself elsewhere, we probably really have an orange ground covered with a thick network of purple (as seen under a lens) with small round meshes. This network ends 3 or 4 mm. from mantle-edge, the inner half of the remainder is therefore a deep orange. The outer half is violet, light proximally but almost black in a narrow band distally. There is a very fine line of primrose-yellow along the extreme edge of the mantle. The under side of the animal is pure white, only the violet of the mantle-edge reappears on the other side.

" Besides the meshes of the network the back is marked by a series of clear cut spaces each defined by a darkened line of purple. These spaces, 2 mm. or so in diameter, may be oval, kidney-shaped, or circular. Those which are near the orange band of the mantle are a clear yellowish white, but the rest are clouded with orange centrally and some have an ill-defined purple spot in the centre.

" Gills and anal papilla are orange on their inner surfaces (those facing the centre of the cup they form), the rest white with a little orange.

" Perfoliate parts of rhinophores brown-red passing into purple at tips. A yellow-white line is conspicuous along the anterior side, running vertically, and very fine lines of the same run horizontally on the posterior halves of the perfoliations."

Mr. Crossland adds that the colour pattern was so complicated and varied so much in different lights, that he abandoned the effort of painting it and only made a black and white sketch.

In a letter he alludes to "the clear bilobed area behind the rhinophores," beneath which the eyes can just be seen.

The preserved specimen has become of a uniform plum colour and shows no markings, but otherwise is as described by Mr. Crossland. The branchiae and rhinophores are both very long and both completely protruded. The branchiae are only 8, but at the base of the hindmost is a small tubercle which is perhaps the beginning of a growing plume.

As in the last species the liver is of a very deep black, only partly concealed by the hermaphrodite gland. The labial armature forms a complete circle, olive in colour, and consisting of

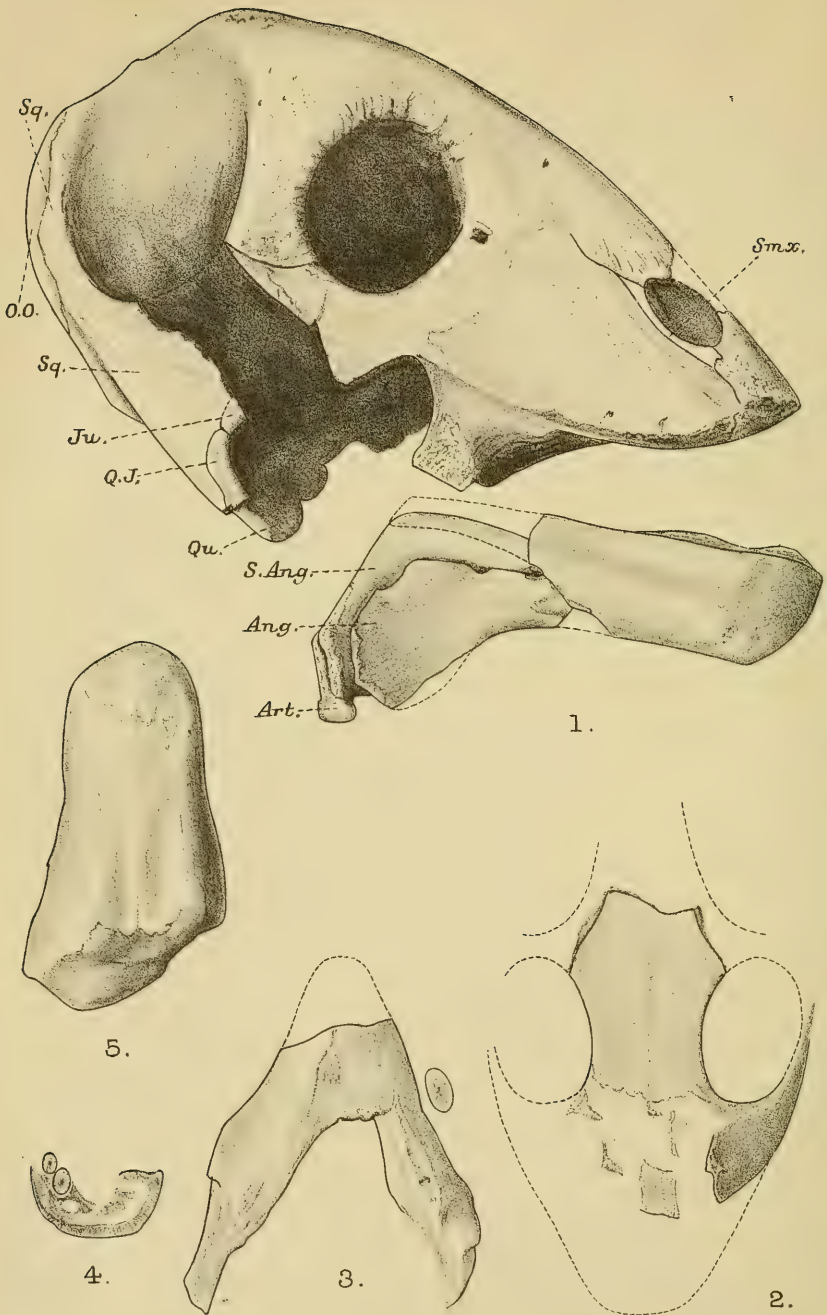
bent rods, not strictly bifid but sometimes bearing a small tubercle near the tip. The formula of the radula is $70 \times 80.0.80$ as a maximum, but it is considerably narrower in the anterior part, which is also markedly darker in colour. There are thickenings on the rhachis as in *Chr. reticulata* but even more distinct. The first laterals are of the usual flattish shape and bear about 4 denticles on either side. The other laterals are rather tall, and erect. They bear 8-12 very faint denticles, visible only under a high power. The outermost laterals are irregularly shaped plates with a few denticles at the top.

In most respects this animal closely resembles Bergh's *Chr. inopinata*. The remarkable coloration is almost identical (unless the light area behind the rhinophores proves to be a characteristic feature found in other specimens), but there are two differences. In Bergh's specimen (1) the branchiæ consisted of five tufts each subdivided into 3, 5 or 8 plumes, (2) the teeth of the radula bore 5-7 distinct denticles. The first difference is hardly of specific value by itself. Typically, the gills of *Chromodoris* are simply pinnate but in some species they show a tendency to subdivide. Still individuals belonging to such species have often normal pinnate gills. The difference in the teeth is more important. If the denticles as drawn by Bergh are not exaggerated, we must either recognize two species (the present animal being characterized by its teeth, simpler gills, and perhaps some persistent differences in coloration) or else admit that considerable variations in the radula are possible. I am inclined to adopt the latter alternative. It will be observed that though the appearance of the teeth in the two specimens is different, this difference depends not on an alteration of shape but in the greater or less development of denticles. Thickenings on the rhachis seem to be indifferently present or absent in several species.

EXPLANATION OF PLATE LXI.

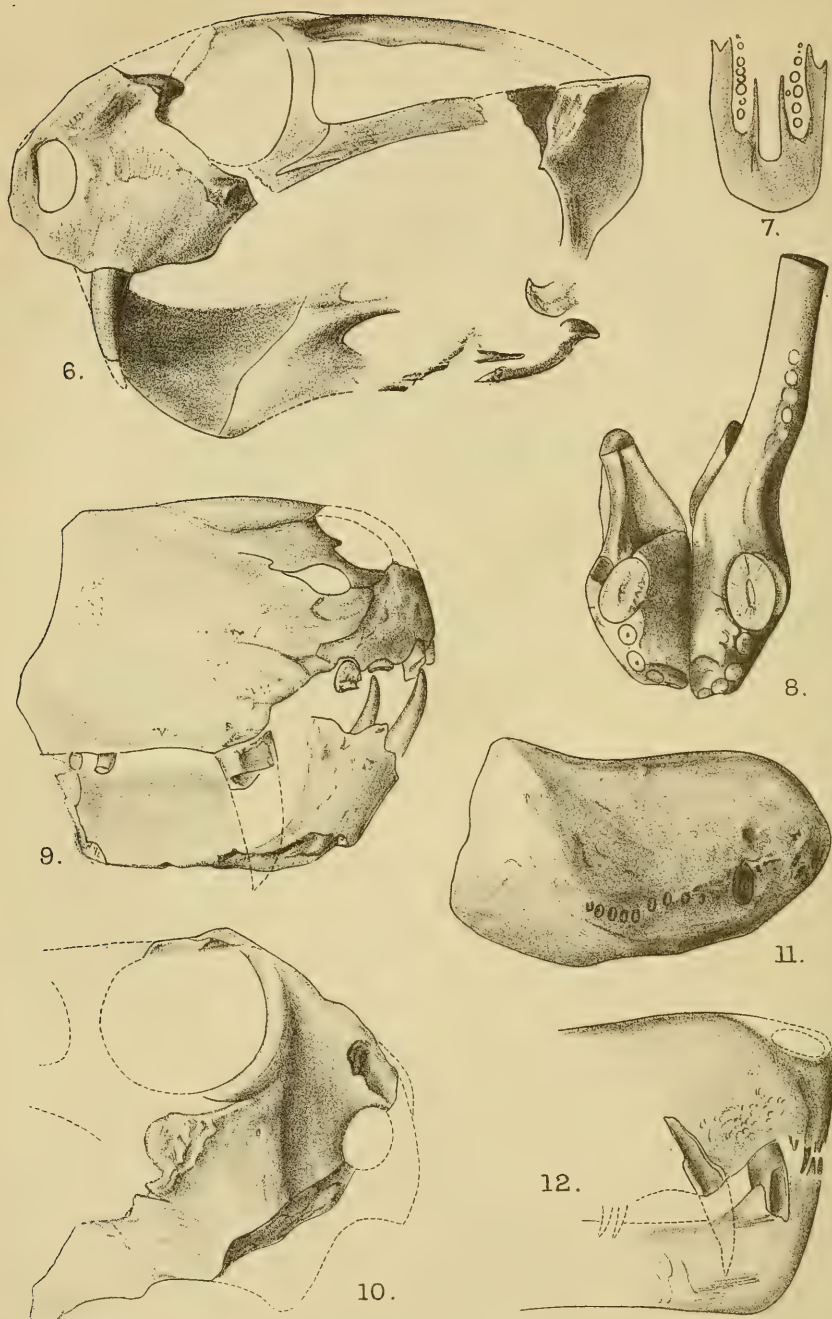
Fig. 1. *Chromodoris reticulata* from a living specimen.

2. *Chromodoris reticulata*. Dorsal view of the mantle and part of body in the living animal; enlarged.
3. *Chromodoris reticulata*. (a) One of the lateral teeth from the middle of a half row; (b) thickening on the rhachis.
4. *Chromodoris tinctoria* from a living specimen.
5. *Chromodoris tinctoria*. Teeth: (a) third lateral, (b) lateral from the middle of a half row, (c) outer lateral, (d) thickening on the rhachis.
6. *Chromodoris inopinata* (?) from a living specimen.
7. *Chromodoris inopinata*, a lateral tooth.



R. Broome, del.

Huth, lith. et imp.



R. Broom, del.

Hutch. lith et imp.

51. On some New South African Permian Reptiles*.

By R. BROOM, D.Sc., C.M.Z.S.

[Received May 23, 1911 : Read June 27, 1911.]

(Plates LXII. & LXIII.†)

Of the following new fossil reptiles a number have been discovered by the Rev. J. H. Whaits of Beaufort West, a most enthusiastic and successful collector. The others have been found by myself. Though none of the species described represent any strikingly new types, the series forms an important addition to our knowledge of the Permian Fauna.

Suborder DINOCEPHALIA.

MOSCHOPS CAPENSIS, gen. et sp. n. (Pl. LXII. fig. 1.)

This important new genus was discovered by Mr. Whaits and myself on the farm Spitzkop in the Moordenaar's Karroo. Remains of a number of skeletons were discovered scattered over and imbedded in an alluvial deposit about a rood in extent. Though the remains were for the most part fragmentary and weathered, and so completely mixed up that it is practically impossible to pick out the bones belonging to any one individual, this matters the less seeing that all the skeletons appear to belong to one species. There is considerable difference in size of the bones, but I think there is reason to believe that this may be accounted for by assuming that the small herd which perished together comprised males, females, and immature animals. As portions of thirteen thigh bones have been discovered, there must have been at least seven individuals.

Owing to the scattered condition of the remains it is impossible to reconstruct the manus and pes and to give the exact number of the pre-sacral and caudal vertebræ, but with these exceptions every detail of the skeleton is known. I hope shortly to give a full description of the remains in a monograph on the Dinocephalia. In the present paper I shall merely give a preliminary description of the skull.

The skull, which I figure and which may be regarded as the type, is, I believe, that of a young female. The left side is much weathered and the whole skull considerably crushed, especially in the occipital region, but otherwise the skull may be regarded as nearly perfect. The greatest length of the skull is 345 mm., and from the occipital condyle to the front of the snout 290 mm.

This new animal resembles *Delphinognathus conocephalus* Seeley so closely, that it was only after very deliberate consideration that I decided to place it in a new genus. That it is specifically

* On p. 1079 Dr. Broom proposes two new generic names, viz., *Arctosuchus* and *Arctognathus*.—EDITOR.

† For explanation of the Plates see p. 1082.

distinct is beyond question, and the marked difference in the temporal region seems to me of sufficient importance to justify the formation of a new genus for its reception.

The nasal region makes with the line of the teeth a sharp angle of about 45° , and the snout is moderately broad. The premaxillaries are small and each carried three teeth.

The maxillary is moderately large and flat and carried 12 teeth, of which the first four are large and may be regarded as canines. The septo-maxillary is a small bone which forms the lower wall of the nostril, and passes backwards a short distance, separating the nasal from the maxilla.

The nasals are fairly large rounded bones which are separated from each other at the lower part by the internasal processes of the premaxillaries.

The orbit is large and round, protected above by a marked thickening of the supraorbital border and behind by a strong postorbital arch. The bones surrounding the orbit appear to be very similar to those of *Delphinognathus* and *Tapinocephalus*, though the limits of the prefrontal have not been clearly made out. The lachrymal foramen is large and opens on the face. The jugal forms the lower border of the orbit. It is a flat and relatively slender bone which passes back to meet the squamosal and the quadrato-jugal.

The quadrato-jugal is a small bone which rests on the descending process of the squamosal and on the quadrate. It does not as in *Delphinognathus* unite with the jugal to enclose a foramen.

The quadrate is very similar to that of the Pelycosaur. In the type it is considerably crushed and displaced.

The squamosal is large. It has a long slender ascending process which forms part of the posterior wall of the temporal fossa and meets the parietal. A descending process supports the quadrate, and an anterior meets the jugal. The upper part of the squamosal rests on a flat bone which forms part of the occiput, and which I regard as the opisthotic from a comparison with the bone in Marsupials and Cynodonts.

The frontals are large and broad and enormously thickened.

The parietals are relatively small, but like the frontals extremely thick. They enclose, as in *Delphinognathus* and *Tapinocephalus*, a large pineal foramen. The edges of the foramen are elevated, but the pineal region stands out less prominently than in *Delphinognathus*.

The occiput is moderately flat, and the condyle large and rounded. The upper side of the condyle has a deep hollow groove for the medulla, and in the middle line immediately below the medullary groove is a small deep pit which passes forward into the basioccipital for the notochord.

The palate is imperfectly known, but appears to be fairly similar to that of *Tapinocephalus*.

The lower jaw is like that of *Delphinognathus* but more fully

known. The dentary forms about half of the jaw, but owing to a slender backward process which rests on the surangular it forms about $\frac{5}{6}$ of the upper border.

The splenial is slender. The angular forms the larger part of the outer side of the posterior part of the jaw, and the slender surangular the upper third. The articular, which has two concavities for the quadrate, is a powerful bone which in front fits in between the angular and surangular on the inner side of the jaw.

The teeth are imperfectly known, but appear to be very similar to those of *Delphinognathus* and *Eccasaurus*. This type closely resembles the tooth figured by Twelvetrees and Seeley as the tooth of *Deuterosaurus*, and if these authors are right in regarding that tooth as belonging to *Deuterosaurus*, there can be no doubt that *Deuterosaurus* is a Dinocephalian closely allied to South African forms.

Suborder ANOMODONTIA.

DIELURODON WHAITSI, gen. et sp. n. (Pl. LXIII. figs. 6 & 7.)

This beautiful little Endothiodont skull was discovered by the Rev. J. H. Whaits on the Beaufort West Commonage. It is fairly complete, but the matrix is so hard that no development has been attempted. Fortunately, the skull was discovered broken into quite a number of scraps, and, but for this, it would have been regarded as belonging to a small species of *Dicynodon*. The lower jaw was, however, broken across obliquely and the fracture revealed the presence of a series of molars. A second very badly weathered specimen appears to me to belong to the same species.

The total length of the skull is 83 mm. From the beak to the front of the orbit is only 22 mm., and to the back of the orbit 41 mm., so that the orbit is entirely in the front half of the skull. The greatest width of the skull at the back part is about 50 mm. The parietal region measures 19 mm. across its narrowest part, and the frontal region is only 13 mm. across. Owing to the forward position of the orbits the facial part is relatively small and also narrow. The tusks are typically *Dicynodont*, but owing to the premaxillaries being very small, placed more forward than in *Dicynodon*.

The molars are arranged in a row like those of *Endothiodon uniseries* Owen, but a second replacing set is seen developing on the inner side of the functional teeth. There are probably about 8 teeth in use in each jaw. The crowns are not displayed in any of the teeth of the type specimen, but in the second specimen a large part of one crown is seen. It is long and slender and has coarse serrations on the anterior and posterior borders. In this the teeth agree with those of *Endothiodon*, and differ from those of *Pristerodon* and *Opisthoctenodon*.

TAOGNATHUS MEGALODON, gen. et sp. n. (Pl. LXII. figs. 2-4.)

This new genus and species is founded on an imperfect and much crushed snout found by myself on the farm Kuilspoort, Beaufort West district. Though little more than the orbital region is preserved, this specimen is manifestly very unlike any type previously known.

The frontal region is flat and moderately broad, the interorbital measurement being 16 mm. The orbit measures about 20 mm. in length.

The greater part of the dentaries is preserved but the anterior part of the beak is missing. The jaw differs from that of all previously known Anomodonts in the much longer portion covered by horn, and also in that the anterior part of the lower jaw instead of being narrower than deep, is here about twice as broad as deep.

The teeth are remarkable in that while there is a tusk it was probably relatively short, and in the lower jaw there are two large teeth each about half the size of the tusk. Not improbably there were two molars in the maxillary and two in the mandible.

The nearest ally of *Taognathus* at present known is *Prodicynodon*, but the affinity is not at all close.

OUDENODON BOLORHINUS, sp. n. (Pl. LXIII. fig. 10.)

This new species of *Oudenodon* was discovered by myself at Kuilspoort, Beaufort West district. Unfortunately, the type consists of only the preorbital portion of the skull, and this is somewhat crushed and weathered.

The most striking characteristics of the species are (1) the extreme shortness of the snout which brings the front of the palate nearly under the orbit, and (2) the thickening of the nasal bones to form a rounded boss which overhangs the nostrils.

The orbit is large and measures about 35 mm. in diameter. The borders are thickened and rounded.

The maxillary bone is short but powerful; the caniniform process being very massive. The upper part of the bone forms part of the thickened lower margin of the orbit and nearly separates the jugal from the lachrymal.

The premaxillary bone is also short and strong, and was probably as represented in the restoration.

The nasals are short but greatly thickened, forming a large median boss the sides of which overhang the nostrils.

The frontal bones are short and comparatively narrow, the interorbital region measuring about 36 mm.

The only species of *Oudenodon* which seems to come near the present one is *Oudenodon strigiceps* Owen, but this latter differs, apart from differences that may be due to crushing, in the much greater size of the nostril and in the much more backward position of the caniniform process.

Suborder THEROCEPHALIA.

ÆLUROSAURUS WHAITSI, sp. n. (Pl. LXIII. fig. 8.)

This new species of *Ælurosaurus* was obtained by Mr. Whaits at Beaufort West. *Ælurosaurus felinus* also occurs at Beaufort West on the same horizon, but the difference between the species is considerable apart from size.

The specimen consists of the greater part of the left dentary, much of each maxilla, the left premaxilla, and numerous other fragments of the skull, besides a large number of fragments of the postcranial skeleton. The skeleton is so imperfect that no long bone is entire, and most are represented by articular ends. A few imperfect vertebræ are present, and a number of disarticulated bones of the manus and pes.

The symphysial part of the jaw makes a less obtuse angle with the lower border of the ramus than in *Ælurosaurus felinus*.

There are four lower incisors and a single large canine. In the type only the deep part of the root of the first incisor is left, so that an accurate measurement of the space occupied by these teeth is impossible. The last is situated very close to the canine. All the incisors are subequal and rounded. The canine measures 10 mm. \times 6.5 mm. at the base; the height is not shown. The molars are small and degenerate. The exact number is uncertain; three remain in the jaw, but apparently two have been shed and replaced by bony tissue. Probably the young animal had 5 molars (possibly 6). There is a large diastema of 15 mm. between the canine and what is probably the occupied position of the 1st molar, and the five molars have a space of 13 mm. From the front of the jaw to the back of the last molar is a distance of 48 mm.

The upper incisors are badly preserved, but the roots are preserved and occupy a space of 21 mm. The upper canine is large and but slightly curved; its anterior border is smooth and rounded; the posterior border is serrated. The antero-posterior measurement at the base is 11 mm.

It seems not improbable that specimen R 855 *a* in the British Museum may belong to this species.

ÆLUROSAURUS TENUIROSTRIS, sp. n. (Pl. LXIII. fig. 9.)

This species is founded on a snout collected by myself at Kuilspoort. It resembles *Ælurosaurus whaitsi* very closely, but differs in that, though it is probably a rather larger form, the snout is more slender and the mandible feebler.

The five upper incisors measure 24 mm. as compared with 21 mm. in *Æ. whaitsi*, and the whole measurement from *i*¹ to *m*⁵ is 65 mm. in *Æ. tenuirostris* as compared with about 52 mm. in *Æ. whaitsi*.

Some of the lower incisors are well preserved. The first is a rounded pointed tooth with a feeble serrated ridge on its outer and posterior side. On the third incisor there is only a very slightly marked ridge, and there are no distinct serrations, though it is possible that they have been worn off by friction against

the upper teeth. The molars are better developed than in *Æ. whaitsi*.

The arrangement of the bones round the nostril is similar to that in *Scylacosaurus* and *Aloposaurus*.

ICTIDOGNATHUS PARVIDENS, gen. et sp. n. (Pl. LXII. fig. 5, & Pl. LXIII. fig. 11.)

This new genus is founded on a small snout found by me at Kuilspoort. It is, with the exception of *Scaloposaurus constrictus*, the smallest known Therocephalian.

From the snout to the orbit measures 46 mm., and the whole skull was probably not more than 90 mm. in length.

Owing to the weathering of the fossil, which was found in a slood and was thus considerably water-worn, the front of the snout is badly preserved and the teeth are very imperfect. There appear to be six incisors, all of small size. There is a fair-sized canine with a very minute 1st canine in front of it. The molars are numerous. Eight are preserved and two are probably lost, possibly three. The dental formula would thus appear to be $i.^6, c.^2, m.^{10}$. The dental formula of *Scaloposaurus* was recently given by me as $i.^6, c.^3, m.^9$, the reason for believing that there are three canines being that the maxillary series begins with one minute tooth followed by two larger than any of the succeeding molars. If we regard the third tooth as a molar, the dental formula becomes the same as in *Ictidognathus*. But though the dental formulæ may be the same, there is no question but that the species must be placed in separate genera, the large canine in the present specimen sufficing to remove it from *Scaloposaurus*. The canine measures antero-posteriorly 3 mm.

ERIPHOSTOMA MICRODON, gen. et sp. n. (Pl. LXIII. fig. 12.)

This small imperfect skull was found by Mr. Whaits at Fraserburg Road. It is in two portions—a rather badly weathered snout, and an equally badly weathered occipital portion. Though the contact is missing, the two fragments can be united with fair accuracy, and the whole skull as restored measures 110 mm. in length. The snout is very flat and deep, measuring in the canine region 27 mm. in greatest width, though the snout with the lower jaw here measures 55 mm. in depth.

The incisors are long, narrow pointed teeth which are situated well to the front, and are apparently only 4 in number. Following the last incisor is a long diastema of 13 mm. corresponding to the position of the large lower canine. The canine measures 4.5 mm. in antero-posterior length. The number of molars is uncertain. Two only are preserved, and these are long, pointed, slender teeth. The number of molars must, however, have been few.

The only genera to which *Eriphostoma* is nearly related are *Ictidosaurus* and *Lycosaurus*. *Ictidosaurus angusticeps*, the only known species, was described by me in 1903 from a specimen in the South-African Museum. *Lycosaurus* was founded by Owen on

a badly weathered skull in the British Museum, which was made the type of *L. pardalis*. Unfortunately, the genus *Lycosaurus* is at present in considerable confusion owing partly to the bad condition of the type, and partly to the fact that two other species, which are not nearly related have been added to the genus.

In *Lycosaurus pardalis*, Owen determined the dental formula to be $i. \frac{3}{3}, c. \frac{1}{1}, m. \frac{5}{5}$. Lydekker not only believes *L. tigrinus* Ow. to be correctly referred to *Lycosaurus*, but thinks it is really indistinguishable from *L. pardalis*. In my opinion the two do not even belong to the same family. The dental formula of *Lycosaurus pardalis* I determine as $i. \frac{5}{5}, c. \frac{2}{2}, m. \frac{4}{4}$. The minute canine in front of the large one is a character very frequently met with in the early Therocephalians of the *Pareiasaurus* zone. The deep square symphysis with the incisor teeth carried well to the front, and the small size of the premaxillary portion are all early characters. Owen gives the locality of the type as "Sneewberg mountain-range," but this is evidently a mistake, and Lydekker in his Catalogue merely states that the specimen is from the "Karoo System of the Cape Colony." It is highly probable that the specimen came from the Gouph.

Lycosaurus tigrinus is a much later type of Therocephalian. Its dental formula is $i. \frac{5}{5}, c. \frac{1}{1}, m. \frac{4 \text{ or } 5}{4 \text{ or } 5}$. As it belongs to a different genus, I would suggest the new generic name *Arctosuchus* to contain *A. tigrinus* Owen.

Lycosaurus curvimola belongs to a still higher type of Therocephalian, which is not nearly allied either to *Lycosaurus* or to *Elurosaurus*. Its dental formula is $i. \frac{4}{4}, c. \frac{1}{1}, m. \frac{5}{5}$. I would suggest for it the new generic name *Arctognathus* to contain *A. curvimola* Owen.

Removing then these other genera and reserving *Lycosaurus* for the type-species, we get a form resembling in many characters *Eriphostoma*, but differing in being larger by a half, in having 5 incisors as against 4, and 2 canines instead of 1 as in *Eriphostoma*. *Ictidosaurus* agrees with *Lycosaurus* as regards the incisor and canine formula, but differs in having a large number of molars and a number of other cranial characters. The dental formulæ of the three genera are as follows:—

Ictidosaurus: $i. \frac{1 \ 2 \ 3 \ 4}{5}; c. \frac{1 \ 2}{2}; m. \frac{1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8}{8}$.

Lycosaurus: $i. \frac{1 \ 2 \ 3 \ 4 \ 5}{5}; c. \frac{1 \ 2}{2}; m. \frac{1 \ 2 \ 3 \ 4}{4}$.

Eriphostoma: $i. \frac{1 \ 2 \ 3 \ 4}{4}; c. \frac{0 \ 2}{2}; m. \frac{? \ ? \ ? \ ?}{?}$.

The Geological Horizons of the Beaufort West Specimens.

Some years ago I endeavoured to subdivide the Beaufort series into palæontological zones. At that time it was only possible to do so on very broad lines. The area is so extensive, and except on the upper part of the series there are no lithological characters

to correspond to the palæontological. Further, as wide areas of the Karroo are covered by wind-blown dust which forms what may be regarded as a sort of loess deposit, and the exposed portions, except in the case of escarpments, are usually isolated, it becomes a matter of extreme difficulty to connect up the various beds. The shales for a thickness of 3000 or 4000 feet present no distinguishing characters, and at present we can do little more than collect fossil specimens and note the localities.

I subdivided the Beaufort into six zones which may be grouped as follows:—

Upper Beaufort	{ 6. <i>Cynognathus</i> Beds.
	{ 5. <i>Procolophon</i> Beds.
Middle Beaufort	4. <i>Lystrosaurus</i> Beds.
	{ 3. <i>Cistecephalus</i> Beds.
Lower Beaufort	{ 2. <i>Endothiodon</i> Beds.
	{ 1. <i>Pareiasaurus</i> Beds.

The *Lystrosaurus* zone probably corresponds to the Lower Triassic; the *Cynognathus* zone to the Upper Triassic. The *Pareiasaurus* beds are probably Middle Permian; the *Endothiodon* and *Cistecephalus* beds are probably Upper Permian. All work done since 1905 has gone to confirm the correctness of the conclusions then arrived at, but it has shown that we will some day be able to subdivide the zones into a large number of subsidiary zones.

The *Pareiasaurus* zone is the oldest one where fossils are numerous. *Pareiasaurus* is its most characteristic form, but there are a host of other known genera, mostly of Therocephalians. Small Anomodonts—*Dicynodon* and *Oudenodon*—are also not uncommon.

Above the *Pareiasaurus* zone we have deposits which measure about 2000 feet, principally characterised by the abundance of *Dicynodon* and *Oudenodon*. Of every six fossils obtained, five are those of *Dicynodon* or *Oudenodon*. As, however, these genera occur at all horizons of the Beaufort, it seems unwise to speak of this as the *Dicynodon* zone. I have therefore called it the *Endothiodon* zone, as *Endothiodonts* are met with throughout it and are known at no other horizon. Therocephalians are not common, but may be met with at any height. Curiously enough, with the exception of *Propappus* and *Saurosternon*, no genera are known from the *Endothiodon* zone which do not belong to the Anomodontia or the Therocephalia.

Above the *Endothiodon* zone is a zone probably not more than 1000 feet thick, which is characterised by the presence of *Cistecephalus*, and the higher types of Therocephalians. The zone is at present the least known of any part of the Beaufort, mainly because since Andrew Bain's time no collector has had an opportunity of doing much with it.

At Beaufort West, one has an opportunity of studying to advantage the *Endothiodon* zone. The township is situated on

an undulating plain which is geologically probably not more than 500 feet above the *Pareiasaurus* zone. The subzone is characterised by the presence of *Endothiodon uniseries* Ow.,—a form that at present is not known from any other part of South Africa. In the Beaufort West district also occurs *Endothiodon bathystoma* Ow., but whether the horizon of this is above or below that of *E. uniseries* is at present unknown.

Near Beaufort West is the escarpment of the Nieuweveld which rises a few miles north of the township to a height of 3000 feet or more, and though it is extremely difficult collecting in the steep slopes of shale, a number of forms of interest have been collected at various horizons.

As *Dicynodon* and *Oudenodon* occur at all levels, it might be thought well to subdivide the zones by the species of *Dicynodon*; but there is a serious difficulty. *Dicynodon* is the most troublesome genus we have to deal with. Specimens differ so greatly in size and shape that one hardly knows what to do unless one does as was practically done by Owen, make every specimen the type of a distinct species. For many years to come the genus *Dicynodon* must remain in utter confusion, and will be useless for stratigraphical work. On the other hand, the Therocephalians will be as reliable guides as Ammonites and Trilobites are in the marine rocks of Europe.

In the following diagram are represented the horizons of the Beaufort West types described in this paper, and of others whose horizons are known. It must, however, be understood that the heights in feet are only approximate.

2000 feet	<i>Ictidognathus parvidens</i> Br.; <i>Ælurosaurus tenuirostris</i> Br.; <i>Oudenodon bolorhinus</i> Br.; <i>Cistecephalus microrhinus</i> Ow.; <i>Dicynodon</i> sp.
1500 feet	<i>Aloposaurus gracilis</i> Br. <i>Dicynodon</i> sp.
1000 feet	<i>Taognathus megalodon</i> Br.; <i>Oudenodon</i> sp.; <i>Dicynodon</i> sp.
500 feet	<i>Dicynodon</i> sp. <i>Dicynodon</i> sp.
Beaufort West horizon ...	<i>Endothiodon uniseries</i> Ow.; <i>Dialurodon whaitsi</i> Br.; <i>Ælurosaurus whaitsi</i> Br.; <i>Scymnosaurus</i> sp.; <i>Dicynodon</i> sp.; <i>Oudenodon</i> sp. <i>Ælurosaurus felinus</i> Ow.

It may be well to regard the *Endothiodon* zone as reaching 1600 feet above Beaufort West, and then passing into the *Cistecephalus* zone.

EXPLANATION OF THE PLATES.

PLATE LXII.

- Fig. 1. Side view of skull of *Moschops capensis* Broom. $\frac{2}{3}$ nat. size. *Ang.* Angular; *Art.* Articular; *Ju.* Jugal; *O.O.* Opisthotic; *Qu.* Quadrate; *Q.J.* Quadratojugal; *S.Ang.* Surangular; *Smx.* Septomaxillary; *Sq.* Squamosal.
 2. Front part of skull of *Taognathus megalodon* Broom. Nat. size.
 3. Under view of lower jaw of *Taognathus megalodon* Broom. Nat. size. The canine of the right side is seen in oblique section.
 4. Section across lower jaw of *Taognathus megalodon* Broom. Nat. size.
 5. Upper view of snout of *Ictidognathus parvidens* Broom. Nat. size.

PLATE LXIII.

- Fig. 6. Side view of skull of *Dialurodon whaitsi* Broom. Nat. size.
 7. Section across lower jaw of *Dialurodon whaitsi* Broom, at the crack indicated in figure 6. Nat. size.
 8. Upper view of mandible of *Elurosauros whaitsi* Broom. Nat. size.
 9. Side view of snout of *Elurosauros tenuirostris* Broom. $\frac{5}{8}$ nat. size.
 10. Side view of snout of *Oudenodon bolorhinus* Broom. $\frac{3}{4}$ nat. size.
 11. Side view of snout of *Ictidognathus parvidens* Broom. Nat. size.
 12. Side view of snout of *Eriphostoma microdon* Broom. $\frac{2}{3}$ nat. size.

52. On a new Tree-Frog from Trinidad, living in the Society's Gardens. By EDWARD G. BOULENGER, Curator of Reptiles to the Society*.

[Received September 20, 1911: Read October 24, 1911.]

(Plate LXIV.†)

In July last the Zoological Society received from Dr. Lewis H. Gough an interesting collection of Batrachians and Reptiles brought back by him from Trinidad. Among these I found examples of three frogs which had not been previously recorded from Trinidad, viz.: *Hyla venulosa* Daud., *Hyla rubra* Daud., and one which is evidently undescribed, and for which I propose the name of *Hyla goughi*, after its discoverer. This little *Hyla*, one of the smallest of the genus, was fortunately represented by numerous specimens, which have enabled me to observe the wide and rapid changes of colour which this species undergoes, and of which an idea can be gained from the annexed coloured plate made by Mr. J. Green at the Gardens under my direction.

HYLA GOUGHII, sp. n. (Pl. LXIV.)

Tongue circular, slightly nicked and slightly free behind. Vomerine teeth in two rounded groups between the choanæ. Head slightly broader than long; snout rounded, a little shorter than the eye, which is large and very prominent. Canthus rostralis feebly marked. Loreal region very slightly concave.

* Communicated by the Secretary.

† For explanation of the Plate see p. 1083.



GOUGH'S TREE FROG.
(HYLA GOUGHI.)

J. Green del. et Chromo lith.



Interorbital region a little broader than the upper eyelid. Tympanum fairly distinct, $\frac{1}{3}$ diameter of eye. Fingers rather short, with small discs, outer $\frac{1}{3}$ webbed. Subarticular tubercles feeble. No projecting rudiment of pollex. Toes $\frac{1}{2}$ webbed. The hind limb being carried forward along the body, the tibio-tarsal articulation reaches between the eye and the end of the snout. Tibia half the length of the head and body. Upper parts smooth, with minute granular warts on the head and the anterior part of the back. Male with a feebly developed subgular vocal sac, forming loose folds.

Coloration.—The rapid changes in colour which this frog undergoes are probably unparalleled in any other Batrachian. The same individual may vary dorsally from dark brown, reddish brown, various shades of yellow, to a very pale greyish white. When startled the majority became of a bright lemon-yellow. In one specimen I observed the head, fore limbs, and anterior part of the body to be dark brown, whilst the posterior part of the body and hind limbs were greyish white. In another specimen the right half of the body was brown, the left half greyish white. A brown or grey marking, often hourglass-shaped, edged with darker or lighter, extending from between the eyes to the anterior third of the back, followed by one or two transverse bars, is frequently present, appearing and disappearing with great rapidity. In one specimen the marking took the shape of a cross-bar between the eyes and two parallel longitudinal bands extending along each side of the entire length of the back. Faint cross-bars on the hind limbs are occasionally present. Lower parts white or yellow. Iris golden, much obscured by brown pigment; a clear golden line borders the pupil, which when fully contracted becomes perfectly linear.

The largest specimen measures 22 mm. from snout to vent.

This little Tree-Frog is extremely agile in its movements, making leaps of quite six feet. In the daytime it usually kept quiet, sticking to the leaves in the terrarium. On arrival the males issued a sharp creaky note, but became perfectly mute after a day or two at the Gardens.

This species appears to be more nearly related to *Hyla strigilata* Spix, from Brazil, and *Hyla misera* Werner (Zool. Anz. 1903, p. 252), from Caracas, Venezuela, than to any others. It differs from both in the shorter snout; from the former also in having more fully webbed toes; from the latter in having a smaller tympanum, and a shorter web between the fingers.

EXPLANATION OF PLATE LXIV.

Gough's Tree-Frog (*Hyla goughi*).

53. A Contribution to the Ornithology of Western Colombia.
By C. E. HELLMAYR, Curator, Division of Birds,
Zoological Museum, Munich *.

[Received April 26, 1911; Read June 13, 1911.]

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II. Account of Mr. M. G. Palmer's localities	1085
III. Account of the Species	1086
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I. INTRODUCTION.

The following account is principally based on a collection of birds made by Mr. Mervyn G. Palmer, one of Mr. W. F. H. Rosenberg's field collectors, in the second half of 1908 and in 1909. Though numbering hardly 700 specimens, the set is of considerable interest, containing a large percentage of rare species as well as several novelties which I have already described, partly in the 'Bulletin of the British Ornithologists' Club,' partly in the 'Revue Française d'Ornithologie.'

The district of Western Colombia in which Mr. Palmer has been working had not been visited by many naturalists before, and, putting aside some scattered notices in scientific periodicals, few accounts have been published about the birds of this little-known region. Our first knowledge is due to the exertions of the celebrated French traveller, Ad. Delattre, who, prior to 1846, made considerable collections in the vicinity of Buenaventura (Chocó Bay), in the Western Cordillera at Juntas, Cali, etc., in the neighbourhood of Popayan, notably on the Puracé, as well as at Pasto, near the Ecuadorian frontier. The new species of Humming-Birds discovered on this trip were made known by Delattre and Bourcier in the 'Revue Zoologique,' vol. ix., 1846, pp. 305-312, while a number of birds belonging to other families are discussed by M. de Lafresnaye in the same journal, vol. x., 1847, pp. 67-79. The next important contribution is Cassin's Catalogue of the Birds collected by Lieut. N. Michler's expedition to the Rivers Truando and Atrato, just south of Darien, published in the 'Proceedings of the Academy of Natural Sciences of Philadelphia' for the year 1860, pp. 132-144, 188-197. This was followed by Selater and Salvin's account of the late T. K. Salmon's extensive collections from the State of Antioquia, in the P. Z. S. 1879, pp. 486-550, wherein 468 species are dealt with. In 1894, Mr. W. F. H. Rosenberg visited the Rio Dagua, working chiefly at Juntas and Cali, in the Western Cordillera. His birds went to the late Adolphe Boucard, who published a list of the Humming-Birds in 'The

* Communicated by Dr. P. L. SELATER, F.R.S., F.Z.S.

Humming Bird,' vol. v., 1895, pp. 5-7, while the bulk of the collection was never reported upon. Mr. Gustav Hopke, in 1896 and 1897, sent a fair series from the same district to Count Berlepsch, who described several new species in the 'Ornithologische Monatsberichte,' vol. v., 1897, pp. 173-176, and in the 'Ornis' xiv., Feb. 1907, pp. 347, 361, 365. Mr. Eugène André, in 1899, forwarded a large collection of birds, from the environs of Buenaventura and the western slope of the Andes above that town, to Comte de Dalmas, of Paris. Unfortunately, the greater part of it was subsequently destroyed by accident, and merely a list of the Trochilidæ published by Messrs. Simon and de Dalmas in 'Ornis,' x., 1901, pp. 216-224. Lastly, Mr. Outram Bangs, the well-known ornithologist of Boston, who had obtained two of Palmer's earlier consignments, gave short accounts of the more interesting species in the 'Proceedings of the Biological Society of Washington,' vol. xxi., 1908, pp. 157-162,* and xxiii., 1910, pp. 71-76, describing several supposed novelties some of which are undoubtedly distinct, while others prove to be identical with species previously named.

The material discussed in this communication is deposited in the collection of the Zoological Museum at Munich with the exception of the few species given in brackets.

II. ACCOUNT OF MR. PALMER'S LOCALITIES.

The whole of Mr. Palmer's collection in possession of the Munich Museum was secured in the province of Chocó, though in two different districts. The bulk is from the hot, tropical valley of the Rio San Juan and its tributaries, the Tamaná, Sipi, Condoto, Calima, Cajón, and Garrapatas Rivers, while a smaller number of specimens was collected on the Pacific slope of the Western Cordillera near the head-waters of the San Juan, at altitudes of from 2800 to 8000 feet.

I am indebted to Mr. Rosenberg for information about the nature and altitude of some of the localities which he had visited himself in 1894. They may be separated into three divisions:—

(A) *Rio Dagua* District.

São Joaquim, Bahia del Chocó (=Buenaventura of European maps).

El Paillon, several hours' journey up the Dagua (E. André).

San José, 600 feet (visited by André and Hopke).

Los Mangos (=Juntas, Rio Dagua), circa 1000 ft. Hot, tropical country.

* The statement that the material came from N.W. Colombia, "just south of Darien," is a mistake. I am informed by Mr. Rosenberg that the San Antonio referred to is a village on the road from Buenaventura to Cali, just over the pass of the Western Cordillera. Mr. Bangs appears to have identified it with the San Antonio, on the Rio Sucio, a tributary of the Atrato, where, however, Mr. M. G. Palmer never was.

Jiménez, 1600 ft., a morning's walk from Los Mangos, in a deep ravine by the side of the pass between Los Mangos and a place called Ventanas, on the road to San Antonio and Cali. Forest country. Above Ventanas the country becomes open.

Naranjo (1900 ft.) and Plano de los Monos (2600 ft.). (Visited by E. André.)

Naranjito, 3900 ft.

Pavas, 4400 ft.; San Luis, Bitaco Valley, 4400 ft.

La Maria, 4700 ft.

Palmar, near La Maria.

San Antonio, R. Cali, 5400 to 5800 ft. On road from Buenaventura to Cali, just over the Pass of the Western Cordillera. Mr. Rosenberg passed through San Antonio many times, but never collected there. The first lot that went to Mr. Bangs was chiefly brought together at this locality.

(B) *Rio San Juan* District (main stream and tributaries). Hot, tropical country covered with dense forests.

R. San Juan: Noanama, alt. 100 ft.; Tadó, farther north, 230 ft.

R. Cajón, a small affluent.

R. Calima: Guineo (sea-level).

R. Sipi: Sipi, 150 ft.; Rio Garrapatas, 150 ft.

R. Condoto: Condoto, 150 ft.

R. Tamaná: Nóvita, 150 ft.; El Tigre, 320 ft.; Juntas, 400 ft.*

(C) *Pacific slopes of the Western Cordillera*, sources of the Rio San Juan.

Pueblo Rico, San Juan slopes, 5200 ft.

Siató, Rio Siató, near Pueblo Rico, 5200 ft.

R. Jamaraya, one of the headwaters of the R. San Juan: Loma Hermosa, 4180 ft.; La Selva, 4600 ft.

Tatamá Mountain. Mr. Palmer collected at various stations (2794 to 8000 feet).

III. ACCOUNT OF THE SPECIES.†

1. *Turdus tristis* DAGUÆ Berl.

[*Merula tristis* Swainson, Philos. Magaz. (n. ser.) i. p. 369 (1827.—Temascaltepec, Mexico).]

Turdus daguæ Berlepsch, Ornith. Monatsber. v. p. 176 (1897.—San José, Rio Dagua, S.W. Colombia); Hartert, Nov. Zool. v. 1898, p. 478 (Cachavi, N.W. Ecuador).

No. 1957. ♂ ad. San Joaquim, Bahia del Choacán, l.viii.08.—Wing 107; tail 84; bill 18 mm.

* Not to be confounded with Juntas on the R. Dagua.

† [The absence of brackets round the name of an author to indicate that his species has been transferred to another genus is not due to Mr. Hellmayr, but is in accordance with the custom of the Zoological Society.—EDITOR.]

Nos. 2078, 2180. ♂ ♂ ad. Sipi, 11.ix., 12.x.08.—Wing 110, 103; tail 87, 79; bill 18 mm.

No. 2299. ♂ ad. Nóvita, Río Tamaná, 16.xi.08.—Wing 106; tail 78; bill 18 mm.

No. 2370. ♀ ad. Nóvita, Río Tamaná, 5.xii.08.—Wing 105; tail 76; bill 18 mm.

No. 2072. ♀ imm. Río Sipi, 10.ix.08.—Wing 107; tail 81; bill 17 mm.

“Iris, feet and bill dark brown.”

In spite of the late Dr. Sharpe's doubts there can be no question that *T. t. daguae* is a perfectly distinct form, though, to my mind, its relations are more correctly expressed by a trinomial appellation. Compared with a good series of *T. tristis cnephosa* Bangs, from Chiriqui and Western Costa Rica (Miravelles), the Colombian birds have shorter wings and tail, a much shorter, slenderer and darker (blackish-brown) bill, and differ also in coloration. The upper parts are deep reddish sepia-brown (instead of greyish olive or olive-brown), the breast and sides dark rufescent brown (instead of pale brownish grey), and the sides of the head deep sepia-brown (instead of sooty black).

T. t. daguae is peculiar to Western Colombia and N.W. Ecuador, whence Miketta and Flemming sent numerous specimens to Mr. Rosenberg. Ecuadorian skins are practically identical with the topotypes forwarded by Mr. Palmer. This Thrush is an inhabitant of the humid lowlands and does not occur in the mountainous parts of the interior.

2. HYLOCICHLA USTULATA SWAINSONII Cab.

[*Turdus ustulatus* Nuttall, Manual Orn. U.S. & Canada, Land Birds, ed. 2, pp. vi, 830 (1840.—Columbia River).]

Turdus swainsonii Cabanis in Tschudi's Fauna Peruan., Aves, p. 188 (1844-46. — “New-Jersey, im Monat October,” coll. Cabanis).

No. 2302. ♀ ad. Nóvita, 17.xi.08. “Iris dark brown, feet pink, maxilla black, mandible light brown, tip black.”

Identical with other specimens from Bogotá, Ecuador, and Venezuela (Merida).

3. MYADESTES RALLOIDES D'Orb.

Muscipeta ralloides D'Orbigny, Voyage dans l'Amér. mérid., Oiseaux, p. 322 (between 1838 & 1847.—Chulamani, Yungas of Bolivia).

Myiadestes ralloides Scater & Salvin, P. Z. S. 1879, p. 492 (Retiro, Concordia, Medellin, S. Elena).

Nos. 3760, 3771. ♂ ♀ ad. Siató, 5200 ft. : Sept. 17, 1909.—Wing 84, 82; tail 75, 72; bill 11 mm.

“Iris dark brown, feet light brown, maxilla black, mandible light brown.”

The specimens agree perfectly with others from Bogotá, while

skins from Cumbre de Valencia, Venezuela, have decidedly smaller bills. Typical Bolivian birds are not available for comparison.

M. ralloides is probably divisible into several geographical races.

4. HELEODYTES ALBOBRUNNEUS HARTERTI Berl.

[*Heleodytes albo-brunneus* Lawrence, Ibis, iv. p. 10 (1862.—“On the line of the Panama Railroad near the summit of the Atlantic Slope”).]

Heleodytes harterti Berlepsch, Ornith., xiv. p. 347 (Feb. 1907.—San José, Rio Dagua, W. Colombia).

No. 2522. ♂ ad. El Tigre, Rio Tamaná, 320 ft., 9.ii.09.—Wing 92; tail 88; bill 23 mm.

No. 2523. ♀ ad. Same locality and date.—Wing 83; tail 78; bill 20 mm.

“Iris reddish brown, feet grey, bill black.”

The specimens agree in coloration with the types kindly lent by Count Berlepsch, and have the back, wings, and tail very much darker, more brownish black, than typical *albobrunneus* from Panama. The dusky markings of the under tail-coverts are less regular, more spot-like, and the bill is black instead of pale brown. The difference in size, however, proves to be not constant, the female from Chocó being scarcely larger than Panama examples*. It may be mentioned that the female has the head all round pure white like the male, while that of *albobrunneus* is said to have the pileum clouded or streaked with pale brown.

H. a. harterti is as yet known only from the Chocó district in Western Colombia.

5. LEUCOLEPIS PHŒOCEPHALUS PHŒOCEPHALUS Scl.

Cyphorhinus (sic) *phæocephalus* Sclater, P. Z. S. 1860, p. 291 (end of 1860.—Esmeraldas, N.W. Ecuador); Sclater & Salvin, P. Z. S. 1879, p. 492 (Remedios, Antioquia).

Cyphorhinus brunnescens Sharpe, Cat. B. Brit. Mus. vi. p. 293 (1881.—“Cauca Valley,” sc. Remedios).

No. 2555. ♀ ad. Juntas, R. Tamaná, 24.ii.09.—Wing 66; tail 32; bill 20 mm.

“Iris brown, feet dark brown, bill black.”

This specimen, a perfectly adult bird, agrees exactly with topotypical examples from N.W. Ecuador (S. Javier), and others from Chimbo. Perhaps it is a trifle darker chestnut on the back and slightly deeper rufous underneath. The type of *C. brunnescens* Sharpe, which I have examined in the British Museum, is merely a young bird of *C. phæocephalus*. Ecuadorian specimens in corresponding plumage are exactly like it. Moreover, it is a well-known fact that in the species of this genus the young birds have the upper parts lighter, more olivaceous brown, and the throat,

* Two specimens measure: wing 80–82; tail 79; bill 19–19½ mm.

foreneck, &c. of a much paler, orange-rufous. This variation is well shown by our series of the nearly allied *L. p. lawrencii* Lawr.* from La Vijagua, Eastern Costa Rica †.

L. p. phaeocephalus is confined to the lowlands of W. Ecuador and W. Colombia.

6. *THRYOPHILUS NIGRICAPILLUS SCHOTTII* Baird.

[*Thryothorus nigricapillus* Scater, P. Z. S. 1860, p. 84 (1860.—Nanegal, W. Ecuador).]

Thryophilus schottii Baird, Review Am. B. i. p. 133 (1864.—Truando R., Colombia).

Thryothorus nigricapillus (nec Scater) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 193 (River Truando).

Thryophilus nigricapillus (nec Scater) Scater & Salvin, P. Z. S. 1879, p. 493 (Remedios, Antioquia).

No. 2585. ♂ ad. Condoto: 2.iv.09.—Wing 67; tail 51; bill 18 mm.

Nos. 2181, 2581, 2622. ♀ ♀ ad. Sipi: 12.x.08; Condoto: 20.iii., 22.iv.09.—Wing 63–65; tail 46–48; bill 17 mm.

Nos. 2618, 2621. ♀ ♀ juv. Condoto: 21, 22.iv.09.—Wing 63½, 65; tail 46, 48; bill 15 mm.

"Iris brown, feet dark grey, bill black, mandible grey in adults, yellow in young birds."

These specimens differ from a good series of *T. n. nigricapillus* from Western Ecuador in having the black cross-bands of the lower parts much broader, more regular as well as more closely set, especially along the middle of the belly. Moreover, chin and throat are distinctly, though narrowly, banded with blackish, while they are uniform white in the Ecuadorian form. Even young birds can easily be distinguished by these characters. In the coloration of the lower parts *T. n. schottii* approaches *T. semibadius* Salv., of Chiriqui and Costa Rica, but has the top of the head black like *T. n. nigricapillus*. Its range is evidently restricted to Western Colombia, from the R. Truando south to the San Juan district. Like its southern representative, it exclusively lives in the hot, low country.

7. *THRYOPHILUS LEUCOPOGON* Salvad. & Festa.

Thryophilus leucopogon Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 357, p. 6 (1899.—Rio Peripa, W. Ecuador); Hellmayr, Journ. f. Orn. 1903, p. 534 (San Javier, N.W. Ecuador).

No. 2440. ♂ ad. Nóvita: 28.xii.08.—Wing 58; tail 38; bill 16½ mm.

* *Cyphorinus lawrencii* Lawrence (ex Scater, MS.), Ann. Lyc. N. H. N.Y. viii. p. 5 (May 1863,—based on *C. cantans* (nec Gmelin) Lawrence, l. c. vii. 1861, p. 293.—Panama Railroad).

† The presence of dusky bars on the primary coverts upon which the late Dr. Sharpe laid much stress is a purely individual character. Five birds from W. Ecuador all have distinct blackish bars, as also the female from Juntas.

"Iris dark red, feet light grey, maxilla black, mandible grey."

This specimen agrees perfectly with others from Western Ecuador. In addition to the one from San Javier in the Vienna Museum mentioned by me, *l. c.*, I have since examined four more specimens from N.W. Ecuador in the Tring Museum; one male and two females also from S. Javier, and a male from Lita, 3000 ft. The wing measures 54-58, the tail 33-37 mm.

T. leucopogon, though a very well-marked species, is nearest to *T. thoracicus* Salv., of Costa Rica, which it closely resembles on the upper parts, but differs in the uniform dull ochreous brown colour of the lower surface, with the exception of the chin and upper throat which are white with slight blackish edgings, while in *T. thoracicus* all the throat and breast feathers are white, broadly margined with black laterally.

T. leucopogon is known only from the coast-belt of Western Ecuador and Colombia.

8. HENICORHINA INORNATA Hellm.

Henicorhina inornata Hellmayr, Journ. f. Ornith. li. p. 528 (1903.—Lita, N.W. Ecuador).

No. 2135. ♀ ad. Sipi, 30.ix.08.—Wing 55; tail $27\frac{1}{2}$; bill 16 mm.

"Iris dark brown, feet and bill black."

This bird is practically identical with the series, including the type, from N.W. Ecuador, in the Munich Museum. The upper parts are of the same bright chestnut-rufous hue, the sides of the breast deep smoky grey, the flanks dark rufous brown, and the base of the lower mandible is clear yellowish white. *H. inornata* is known only from Western Colombia and N.W. Ecuador, where it inhabits the forests of the humid lowlands as well as the lower slopes, up to 3000 feet (Lita).

[In the mountains bordering the Cauca Valley it is represented by another species which Mr. Bangs* has lately separated as *H. leucosticta eucharis*, but which I cannot satisfactorily distinguish from *H. l. prosthaleuca*, of Chiriqui and Eastern Costa Rica. Having before me two fine specimens†, I can positively state that it has nothing to do with *H. leucosticta* of Guiana and East Venezuela. Mr. Bangs was apparently misled by a black-crowned male, but this character is of very little importance in view of the fact that specimens of *prosthaleuca* in worn plumage often have the crown nearly uniform black, the brown tips to the feathers having disappeared through abrasion. Moreover, the two skins from Primavera have the feathers of the pileum broadly tipped with umber-brown and the back etc. dull russet-brown, exactly as in *prosthaleuca*. While a larger series from Colombia might ultimately reveal some slight differences, the evidence at hand is not in favour of the southern form being separable.]

* Proc. Biol. Soc. Wash. xxiii. p. 74 (1910.—Pavas, W. Colombia, 4400 feet).

† ♂ ♀ from Primavera, Cauca R., 5100 feet, Raap coll., Tring Museum.

9. SEIURUS NOVEBORACENSIS NOVEBORACENSIS Gm.

Motacilla noveboracensis Gmelin, Syst. Nat. 1, ii. p. 958 (1789—*ex* Daubenton, Pl. Enl. 752, fig. 2: Louisiana).

Siurus noveboracensis Scater & Salvin, P. Z. S. 1879, p. 493 (Concordia, Medellin).

Nos. 2131, 2153, 2171. ♂ ♀ ad., (sex not determined). Sipi: 30.ix., 3,9.x.08.

"Iris dark brown, feet brown, maxilla black, mandible brown."

These birds apparently belong to typical *noveboracensis*. Quite similar specimens we have from Ecuador and Bogotá collections.

A common winter visitor to Colombia.

10. MNIOTILTA VARIA Linn.

Motacilla varia Linnæus, Syst. Nat. xii. 1, p. 333 (1766—*ex* Brisson & Sloane: Jamaica and San Domingo).

Mniotilta varia Scater & Salvin, P. Z. S. 1879, p. 493 (Concordia etc.); Berlepsch, Journ. f. Orn. 1884, p. 282 (Bucaramanga).

Nos. 2807, 2855. ♂ ♀. Pueblo Rico: 27.x.; Loma Hermosa: 23.x.09.

"Iris and feet dark brown, maxilla black, mandible white."

A common winter visitor to Colombia.

11. DENDROICA CASTANEA Wilson.

Sylvia castanea Wilson, Amer. Orn. ii. p. 97, pl. 14. f. 4 (1810.—Pennsylvania).

Dendroica castanea Scater & Salvin, P. Z. S. 1879, p. 494 (Remedios); Berlepsch, Journ. f. Orn. 1884, p. 282 (Bucaramanga).

Nos. 2317, 2331, 2381. ♂ ♂ juv. Nóvita: 20,24.xi., 9.xii.08.

"Iris dark brown, feet grey, maxilla black, mandible grey."

12. DENDROICA ÆSTIVA ÆSTIVA Gm.

Motacilla æstiva Gmelin, Syst. Nat. 1, ii. p. 996 (1789—*ex* Brisson & Daubenton, Pl. Enl. 58, fig. 2: Canada).

Dendroica æstiva, Scater & Salvin, l. c. p. 494 (Medellin); Berlepsch, l. c. p. 282 (Bucaramanga).

Nos. 2593, 2136. ♂ ad., ♂ juv. Condoto: 12.ix.; Sipi: 30.ix.08.

"Iris dark brown, feet light brown, maxilla black, mandible grey."

13. BASILEUTERUS TRISTRIATUS TRISTRIATUS Tsch.

Myiodiodes tristriatus Tschudi in Arch. f. Naturg. 10, i. p. 283 (1844.—Peru); *cfr.* Berlepsch & Hellmayr, Journ. f. Orn. 1905, p. 7 (crit.).

Basileuterus tristriatus Berlepsch, Journ. f. Orn. 1884, p. 283 (Bucaramanga).

B. auricularis Sharpe, Cat. B. Brit. Mus. x. p. 386 (1885.—Bogotá; Pallatanga, W. Ecuador; Simacu, Bolivia; no type specified).

B. melanotis dædalus Bangs, Proc. Biol. Soc. Wash. xxi. p. 160 (1908.—San Antonio, Rio Cali, W. Colombia, 5800 ft.).

No. 3748. ♂ ad. Pueblo Rico, 5200 ft., 10.ix.09.—Wing 65; tail 57; bill $10\frac{1}{2}$ mm.

Nos. 3749, 3751. ♀ (?) ad., ♀ ad. Pueblo Rico: 10, 11.ix.09.—Wing 64, $61\frac{1}{2}$; tail 60, 56; bill 10 mm.

“Iris dark brown, feet greyish yellow, maxilla black, mandible grey.”

These specimens agree with a series from Bogotá, Ecuador, and Peru, some of which I had previously compared and found identical with Tschudi's type kindly forwarded by the authorities of the Neuchâtel Museum. I am unable to discover any constant character on which to separate the Colombian and Ecuadorian birds from typical Peruvian skins, *B. auricularis* Sharpe being based on purely individual variations, such as the colour of the pale crown stripe etc. When compared with *B. tristriatus melanotis* Lawr. *, of Costa Rica and Chiriqui, the three examples from Pueblo Rico differ exactly as indicated by Mr. Bangs, viz., much brighter green back, deeper (about maize) yellow underparts, and large, blackish loreal spot. However, in all these points they are absolutely similar to typical *tristriatus*, to which Mr. Bangs, evidently misled by Sharpe's key, does not make any reference at all. *B. t. tristriatus* had already been recorded from Bucaramanga, N. Colombia, by Count Berlepsch.

While I cannot admit the distinctness of the Colombian birds—for which, moreover, Sharpe's term *auricularis* would be an earlier name—the inhabitants of the mountains of Venezuela constitute a fairly well-defined race, *B. t. meridanus* Sharpe †, recognisable by the reduction or absence of the black loreal and auricular spots.

We have in the Munich Museum, three adults from Merida, and five males and one female from the Cumbra de Valencia; and, at Tring, I have examined two skins from Caripé, State of Cumaná, and one adult from Bucarito, Tocuyo (*Mocquerys*).

14. *BASILEUTERUS FULVICAUDA SEMICERVINUS* ScL.

[*Muscicapa fulvicauda* Spix, Av. Bras. ii. p. 20, pl. xxviii. fig. 2 (1825—no locality)].

Basileuterus semicervinus Selater, P. Z. S. 1860, p. 84 (1860.—Nanegal, W. Ecuador); Selater & Salvin, P. Z. S. 1879, p. 494 (Remedios, Neche); Berlepsch, Journ. f. Orn. 1884, p. 284 (Bucaramanga).

No. 613. ♀ ad. Juntas, Rio Dagua, 1000 ft.: 1.viii.07.—Wing 60; tail 49; bill $12\frac{1}{2}$ mm.

* *B. melanotis* Lawrence, Ann. Lyc. N. H. N.Y. ix. p. 95 (1868.—Cervantes, Costa Rica).

† *B. meridanus* Sharpe, Cat. B. Brit. Mus. x. p. 387 (1885.—Merida, Venezuela).

No. 2170. ♀ ad. Rio Garrapatas, Sipi, 150 ft.: 8.x.08.—
Wing 60; tail 48; bill 12 mm.

"Iris dark brown, feet light brown, bill black."

These, as well as several other specimens from W. Colombia in the Tring Museum (Raap and Palmer coll.), are practically identical with topotypical skins from Nanegal, W. Ecuador. A series from N.W. Ecuador is not different either.

15. *SETOPHAGA RUTICILLA* Linn.

Motacilla ruticilla Linnæus, Syst. Nat. x. p. 186 (1758—*ex* Catesby: Carolina).

Setophaga ruticilla Sclater & Salvin, l. c. p. 494 (Concordia, Medellín); Berlepsch, l. c. p. 284 (Bucaramanga).

No. 2392. ♂ ad. Nóvita: 11.xii.09.

No. 3775, —. ♂ ♂ ad. Pueblo Rico: xi.09; Siató: 25.xi.09.

"Iris dark brown, feet black, maxilla black, mandible brown."

A common winter visitor to the north-western States of South America.

16. *PROGNE CHALYBEA CHALYBEA* Gm.

Hirundo chalybea Gmelin, Syst. Nat. 1, ii. p. 1026 (1789—*ex* Brisson and Buffon: Cayenne).

Progne chalybea Sclater & Salvin, l. c. p. 495 (Remedios).

Nos. 2356, 2360. ♂ ♂ ad. Nóvita: 30.xi, 1.xii.08.—Wing 128, 125; tail 69; bill 12, 11 mm.

"Iris, feet, and bill black."

Agreeing with examples from Venezuela, Bogotá, and Cayenne.

17. *STELGIDOPTERYX RUFICOLLIS UROPYGIALIS* Lawr.

[*Hirundo ruficollis* Vieillot, Nouv. Dict. xiv. p. 523 (1817.—"Brésil").]

Cotyle uropygialis Lawrence, Ibis, v. p. 181 (1863.—Panama).

Stelgidopteryx uropygialis Sclater & Salvin, l. c. p. 496 (Remedios); Berlepsch, J. f. Orn. 1884, p. 285 (Bucaramanga).

Nos. 2106, 2107. ♂ ♀ ad. Sipi: 22.ix.08.—Wing 107, 92; tail 56, 47 mm.

"Iris dark brown, feet and bill black."

Agreeing with specimens from Chiriquí and Costa Rica. *Cfr.* Nov. Zool. xiii. 1906, p. 13.

18. *DIGLOSSOPIS CÆRULESCENS CÆRULESCENS* Scl.

Diglossopsis cærulescens Sclater, Ann. Mag. N. Hist. (2) xvii. p. 467 (1856.—Caraccas, in Venezuela); Sclater & Salvin, P. Z. S. 1879, p. 496 (Santa Elena).

Diglossa cærulescens Berlepsch, Journ. f. Orn. 1884, p. 286 (Bucaramanga).

Proc. Zool. Soc.—1911, No. LXXIV. 74

No. —. ♂ ad. Tatamá, 2794 ft.: 12.x.09.—Wing 72; tail 58; bill 13 mm.

"Iris reddish brown, feet dark grey, bill black."

Agrees with Bogotá skins, whereas specimens from Merida are a darker and more uniform bluish colour below with scarcely any greyish admixture on the vent. Topotypical birds from Caraccas are not available for comparison.

D. c. caerulescens is known only from the mountains of Colombia and Venezuela. In Peru it is replaced by the nearly allied *D. c. pallida* Berl. & Stolz. *

19. DACNIS VENUSTA FULIGINATA Bangs.

[*Dacnis venusta* Lawrence, Ann. Lyc. N. H. N.Y. vii. p. 464 (1862.—Panama Railroad)]

D. venusta fuliginata Bangs, Proc. Biol. Soc. Wash. xxi. p. 160 (1908.—Jiménez, W. Colombia).

D. venusta (nec Lawrence), Sclater & Salvin, P. Z. S. 1879, p. 497 (Remedios).

No. 2215. ♂ ad. Noanama: 22.x.08.—Wing 62; tail 39; bill 11 mm.

Nos. 2243, 2244. ♂ ♂ ad. Nóvita: 7.x.08.—Wing $64\frac{1}{2}$, 65; tail $40\frac{1}{2}$, 41; bill 10, 11 mm.

No. 385. ♂ ad. Jiménez, 1600 ft.: 12.vi.07.—Wing 63; tail 40; bill $10\frac{1}{2}$ mm.

No. —. ♂ ad. Rio Dagua: 8.vi.95. Rosenberg coll.—Wing 63; tail $40\frac{1}{2}$; bill 10 mm.

No. —. ♀ ad. Rio Dagua: 10.vii.95. Rosenberg coll.—Wing 64; tail 42; bill 11 mm.

"Iris crimson, bill and feet black."

In addition, I have examined two males from Jiménez (June 14, '28), in Mr. Rosenberg's possession. *D. v. fuliginata* is a perfectly good form. Compared with the series from Panama, Chiriqui and Costa Rica in the Munich Museum, the males sent by Mr. Palmer differ in having the underparts much darker, deep black with hardly a trace of the greenish hue so conspicuous in the Central American birds. The female is smaller †, and rather deeper ochraceous buff on the lower belly and under tail-coverts than those from more northern localities. The bill, in the southern race, is constantly shorter. Birds from Costa Rica and Chiriqui have much longer wings and tail, while those from Panama, in size, approach *D. v. fuliginata*.

Eight adult males from Chiriqui and Costa Rica measure: wing 67–70; tail 43–45; bill 12–13 mm.

Three adult males from Panama (Railroad) measure: wing $63\frac{1}{2}$ –66; tail 42–43; bill 12–13 mm.

* P. Z. S. 1896, p. 334 (Chachapoyos, N. Peru; Garita del Sol, C. Peru).

† Three adult females from Chiriqui measure: wing 65–67; tail $43\frac{1}{2}$ –44; bill 13 mm.

20. *DACNIS CAYANA CÆREBICOLOR* Scl.

[*Motacilla cayana* Linnaeus, Syst. Nat. xii. 1, p. 336 (1766—*ex* Brisson: Cayenne; excl. Hernandez—Mexico)].

Dacnis cærebicolor Selater, Contrib. to Ornith. 1851, pp. 106–12 (1851 (?)—“New Granada?” sc. *Bogotá*, *cfr.* Selater, Cat. Coll. Amer. B., 1862, p. 51); Selater & Salvin, P. Z. S. 1879, p. 497 (Remedios—♂ imm., “not quite so bright as specimens from Bogotá”); Hartert, Nov. Zool. v. p. 481 (Paramba, N.W. Ecuador).

D. cayana (errore) Selater & Salvin, l. c. p. 496 (Remedios).

Nos. 2006, 2205, 2214. ♂ ♂ ad. Noanama: 24.viii., 20.22.x.08.—Wing 61–64½; tail 42½–43½; bill 11–11½ mm.

Nos. 2319, 2348, 2187. ♂ ♂ ad. Nóvita: 21.28.xi.; Sipi: 13.x.08.—Wing 61–63; tail 42½–44; bill 11–11¾ mm.

No. 2657. ♂ ad. Tadó: 21.v.09.—Wing 63; tail 42½; bill 12 mm.

No. 2007. ♀ ad. Noanama: 24.viii.08.—Wing 59; tail 42; bill 12 mm.

Nos. 2320, 2374, 2382. ♀ ♀ ad. Nóvita: 21.xi., 7, 9.xii.08.—Wing 59–62; tail 40–43; bill 10½–12 mm.

Nos. 2188, 2073. ♀ ♀ ad. Sipi: 10.ix., 13.x.08.—Wing 63, 61; tail 43, 42½; bill 11 mm.

Nos. 2631, 2669. ♀ ♀ imm. Tadó: 3, 27.v.09.—Wing 60, 62; tail 43, 44; bill 11, 11½ mm.

Nos. 507, 508, 518, 541, 564, 570, 647, 688. ♂ ♂ ad. Jiménez, 1600 ft., 28.vi., 12, 13, 18, 23, 24.vii., 9.viii.07.—Wing 63½–67; tail 43–47; bill 12–13 mm.

No. —. ♂ ad. Rio Oscuro, W. Cordillera, 3000 ft., June 1898, Batty coll.—Wing 68; tail 49; bill 12¾ mm.

Nos. 384, 400, 401, 486, 577, 642, 652. ♀ ♀. Jiménez, June to Aug.—Wing 60–63; tail 42–44; bill 11½–12 mm.

“Iris dark red in males, dark brown in females, feet pink, bill black.”

This series is rather puzzling. The males show a wide amount of individual variation, every shade of blue between the ultramarine of *D. c. napaea* and the deep purplish blue of *D. c. cærebicolor* (of Bogotá) being represented. The lightest specimen, no. 2006, from Noanama has the blue portions of the plumage of exactly the same tone, and the mantle as well as the gular patch as dull (greenish black) as topotypical Santa Marta skins, from which it only differs by its smaller size and shorter bill. Next come no. 2214 (Noanama), no. 564 (Jiménez), and the male from Rio Oscuro, which are just a shade darker, more cobalt, with the black of the mantle and throat deeper, less obscured by dull greenish tips. Then follow ten specimens which have the plumage more or less tinged with purple. Finally, three birds, nos. 2187 (Sipi), 508 and 541 (Jiménez), and a fourth from Paramba, N.W. Ecuador, are quite as bright and deep purplish blue as Bogotá skins.

In coloration, there is no constant difference between the birds from the foot-hills (Noanama, N6vita, Tad6, Sipi) and those from the more elevated districts (Jim6nez, 1600 to 2900 ft.; Rio Oscuro, 3000 ft.). The former are, however, on the average, smaller, and have a shorter, slenderer bill, while the males from Jim6nez, etc., in dimensions, agree with skins from Bogot6 and Bucaramanga.

The females also are rather variable. Most of them have the top and sides of the head turquoise-blue, scarcely darker than in the female of *D. c. ultramarina* from Panama, while in two or three these parts are of the same dark ultramarine-blue colour as in Bogot6 skins of *D. c. c6erebicolor*.

From what I have said above, it is evident that the majority of the West Colombian birds are not typical *c6erebicolor*; but in view of their great individual variation, which completely connects *napaea*, of Santa Marta, and *c6erebicolor*, of the Eastern Cordillera, it seems inadvisable to separate them subspecifically since the new "form" would mainly consist of "intermediates." One thing, however, results from the study of that series, viz., that both *napaea* and *c6erebicolor* are merely geographical races of *D. cayana*, the passage being formed by *D. c. ultramarina*. Thus, we have the following forms:—

- (a) *D. c. cayana* Linn. Eastern South America from Southern Brazil to Trinidad, Guiana and Venezuela.
- (b) *D. c. glaucogularis* Berl. & Stolz. * From the eastern slopes of the Colombian Andes south through Peru to Eastern Bolivia and Western Brazil (Mattogrosso).
- (c) *D. c. callaina* Bangs †. Chiriqui and S.W. Costa Rica (Pozo Azul etc.).
- (d) *D. c. ultramarina* Lawr. ‡ Isthmus of Panama, Eastern Costa Rica, E. Nicaragua.
- (e) *D. c. napaea* Bangs §. Santa Marta District, N. Colombia.
- (f) *D. c. c6erebicolor* Schl. Andes of Colombia (Western and Eastern Cordillera) and N.W. Ecuador. Typical in the Eastern Cordillera.

On some future occasion I hope to give more details about the variation and geographical distribution of the various races.

21. CHLOROPHANES SPIZA EXSUL Berl. & Tacz. (?)

[*Motacilla spiza* Linnæus, Syst. Nat. x. p. 188 (1758—*ex* Edwards: Surinam).]

Chlorophanes spiza exsul Berlepsch & Taczanowski, P. Z. S. 1883, p. 543 (1884—Chimbo, S.W. Ecuador).

* P. Z. S. 1896, p. 336 (Central Peru: La Gloria, La Merced).

† Proc. Biol. Soc. Wash. xviii. p. 154 (1905.—Divala, Chiriqui).

‡ Proc. Acad. N. Sci. Philad. 1864, p. 106 (Isthmus of Panama).

§ Proc. Biol. Soc. Wash. xii. p. 143 (1893.—Santa Marta).

C. atricapilla (errore) Sclater & Salvin, P. Z. S. 1879, p. 497 (Concordia, Remedios).

Nos. 2211, 2248, 2385. ♂ ♂ ad. Noanama; 22.x.; Nóvita: 8.xi., 10.xii.08.—Wing 69; tail 45–48; bill 13–13½ mm.

Nos. 2212, 2333. ♂ juv., ♀ ad. Nóvita: 24.xi.; Noanama: 22.x.08.—Wing 68, 65; tail 45; bill 13½ mm.

“Iris crimson, feet green, maxilla black, mandible yellow.”

The adult males agree with typical specimens from West Ecuador in size and in smallness of the bill; but the coloration is more bluish, especially below, though much less so than in the Upper Amazonian race, *C. s. cærulescens* Cass.* Birds from Chiriqui and Costa Rica (El General de Terraba, Carrillo, La Vijagua, etc.) are again more greenish, have longer wings (70–74 mm.), and a longer, more robust bill (14½–16½ mm.). They are unquestionably subspecifically distinct. A larger series might perhaps enable us to separate the West Colombian birds, but for the present I leave them with *C. s. exsul*. According to this view, *C. s. exsul* ranges from S.W. Ecuador north to the Pacific slopes of Colombia.

22. CYANERPES CÆRULEA MICRORHYNCHA Berl.

[*Certhia cærulea* Linnæus, Syst. Nat. x. p. 118 (1758—*ex* Edwards: Surinam).]

Cæreba cærulea microrhyncha Berlepsch, Journ. f. Orn. xxxii. p. 287 (1884—part.: type ex Bucaramanga, N. Colombia).

Cæreba cærulea (nec Linnæus) Sclater & Salvin, P. Z. S. 1879, p. 497 (Remedios, Medellín).

Nos. 2257, 2262. ♂ ♂ ad. Nóvita: 10, 11.xi.08.—Wing 55, 53½; tail 29, 27½; bill 18 mm.

No. 1961. ♂ ad. San Joaquim, Bahia del Chocó, 3.viii.08.—Wing 54; tail 28; bill 17½ mm.

No. 2241. ♂ ad. Rio Cajón: 5.xi.08.—Wing 55; tail 28; bill 17½ mm.

No. 2233. ♂ juv. Cajón: 2.xi.08.

Nos. 2242, 2349. ♀ ♀ ad. Rio Cajón: 5.xi.08; Nóvita: 28.xi.08.—Wing 55; tail 27; bill 17 mm.

“Iris dark brown (♂ ♂), black (♀), bill black, feet wax-yellow (♂), green (♀).”

The adult males agree in the shortness of the bill, and in the pale azure-blue colour of the cheeks and anterior portion of the crown, with a number of Bogotá skins, but have slightly shorter wings and tail. Two adult males from Pozuzo (prov. Huánuco, Peru) are equally small while the bill is even a little shorter. The difference in size is, however, not likely to be constant, since a single male from San Augustin, N. Bolivia (3500 feet), has wings, tail, and bill fully as long as Colombian examples. There

* *Chlorophanes cærulescens* Cassin, Proc. Acad. N. Sc. Philad. Nov. 1864, p. 268 (1865.—Yuracaré, N.E. Bolivia).

can be no question that *C. c. microrhyncha* is a perfectly valid form. *Cfr.* my remarks in Nov. Zool. xii. 1905, p. 9, and *l. c.* xiv. 1907, pp. 42-43.

Its range extends from the mountains of Colombia south to Northern Bolivia.

23. *CEREBIA CHLOROPYGA MEXICANA* Scl.

[*Certhiola chloropyga* Cabanis, Mus. Hein. i. p. 97 (1850.—Bahia).]

Certhiola mexicana Sclater, P. Z. S. 1856, p. 286 (Jan. 1857.—S. Mexico, probably Vera Cruz); Sclater & Salvin, P. Z. S. 1879, p. 497 (Remedios, Medellin).

No. 2822. ♀ ad. Pueblo Rico, 5200 ft.: 2.xi.09.—Wing 52½; tail 32; bill 12 mm.

"Iris dark brown, feet dark grey, bill black."

Identical with skins from Bogotá and Western Ecuador which I am unable to separate from others taken in Mexico and Costa Rica.

Birds from Bucaramanga form the transition to *C. c. luteola* Cab. *Cfr.* Berlepsch, Journ. f. Orn. 1884, p. 288.

24. *ORYZOBORUS FUNEREUS ÆTHIOPS* Scl.

[*Oryzoborus funereus* Sclater, P. Z. S. 1859, p. 378 (1860.—Oaxaca, Mexico).]

Oryzoborus æthiops Sclater, P. Z. S. 1860, p. 88 (1860.—Nanegal, W. Ecuador).

No. 1988. ♂ ad. Mouth of Calima, San Juan River, 13.viii.08.—Wing 55; tail 51; bill 12 mm.

"Iris dark brown, feet and bill black."

This bird agrees, in size and colour, with a series from Western Ecuador in the Munich Museum. Specimens from Guatemala, which I take to be typical *O. f. funereus*, have longer wings (60 mm.) and tail (54 mm.), a slightly larger bill, and the females are much brighter cinnamon underneath. These slight differences might disappear on comparison of a larger series of Central American skins, but, for the present, I am unwilling to unite the two forms without further evidence. *O. f. æthiops*, as defined here, ranges over the forest district of Western Colombia and Ecuador. Specimens from Antioquia* and Santa Marta which I have not seen may also be referable to the southern race.

25. *SPOROPHILA OPHTHALMICA* Scl.

Spermophila ophthalmica Sclater, P. Z. S. 1860, p. 276 (end of 1860—Babahoyo, W. Ecuador); Sharpe, Cat. Birds, xii. p. 120 (Chocó Bay).

Nos. 1979, 1991. ♂ ♂ ad. Mouth of Calima, 13.viii.08;

* *O. funereus* Scl. & Salvin, P. Z. S. 1879, p. 506 (Medellin).

Guineo, R. Calima: 7.viii.08.—Wing 54–55; tail 45, 47; bill 10 mm.

No. 2134. ♀ ad. Sipi: 30.ix.08.—Wing 53; tail 43; bill 10 mm.

“Iris dark brown, feet and bill black.”

One of the males (no. 1979: Guineo) agrees with West Ecuadorian skins, the throat being white with a small black spot at the base of the mandibular rami. In the other specimen (no. 1991) the feathers of the upper throat are black, tipped with white. Both have the black breast-band rather wider than the large majority of Ecuador skins, though one or two of the latter hardly differ in that respect.

The male from the mouth of the Calima (no. 1991) approaches very closely black-throated males of *S. aurita*, and can only be distinguished by the white tips to the feathers of the throat!

S. ophthalmica is no doubt merely a southern race of *S. aurita**, but until the status of this puzzling “species” is better understood, it would be unwise to employ a trinomial appellation. Mr. Ridgway’s remarks (in Bull. U. S. Mus. no. 50, Part 1, 1901, p. 573) should be carefully consulted.

S. ophthalmica is restricted to W. Ecuador and S.W. Colombia.

26. TERSINA † VIRIDIS OCCIDENTALIS Scl.

[*Hirundo viridis* Illiger, Prodr. Syst. Mamm. & Av. p. 229 (1811—based on “L’Hirondelle verte,” Temminck, Cat. Syst., 1807, p. 245, no. 986: Brasilia; = ♀); cfr. Allen, Bull. Amer. Mus. N. Y. ii. 1889, p. 70.]

Procnias occidentalis Sclater, P. Z. S. 1854, p. 249 (Apr. 1855). —“Nova Grenada”).

P. tersa (nec Linnaeus) Sclater & Salvin, P. Z. S. 1879, p. 497 (Remedios, Antioquia).

P. caerulea occidentalis Berlepsch, Journ. f. Orn. 1884, p. 288 (Bucaramanga).

No. 2035. ♂ ad. Noanama: 29.viii.08.—Wing 87; tail 56; bill 9 mm.

Nos. 2404–6, 2412. ♂ ♂ ad. Nóvita: 16, 18.xii.08.—Wing 81–85; tail 52–55; bill 9–10 mm.

“Iris brown, feet and bill black.”

The series agrees, in size and coloration, with other specimens from Bogotá, Eastern Ecuador, Venezuela (Cumaná), etc. Cfr. my remarks in Nov. Zool. xvii. 1910, p. 271. Birds from Eastern Brazil (Bahia, Rio) are much larger, and the males have the plumage of a decidedly paler, more greenish blue (nile-blue).

* Not having seen white-throated males (= *hicksii* Lawr.) I am unable to say in what way they differ from *S. ophthalmica*, but, judging from published descriptions, the only character of the northern form appears to consist in the rather wider black band across the chest.

† For change of generic name see Ridgway, Bull. U. S. Mus. no. 50, pt. iv. p. 880, footnote b

27. *EUPHONIA FULVICRISSA* Sci. [a subsp. ?].

Euphonia fulvicrissa Scater, P. Z. S. 1856, p. 276 (Jan. 1857.—“Santa Martha in New Grenada”); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 143 (Falls of the Truando); Scater & Salvin, P. Z. S. 1879, p. 498 (Remedios, Neche: Antioquia); Berlepsch, Journ. f. Orn. 1884, p. 288 (Bucaramanga).

No. 2036. ♂ ad. Noanama, 29.viii.08.—Wing 51; tail 29; bill $8\frac{3}{4}$ mm.

No. 2530. ♀ ad. El Tigre, 10.ii.09.—Wing 50; tail 28; bill 8 mm.

“Iris dark brown, feet black, bill black, lower mandible blue.”

The adult male from Noanama and another, picked out from a set of Bogotá skins, in the Munich Museum are exactly intermediate between specimens of *E. fulvicrissa*, from Panama and Chiriqui, and *E. f. purpurascens* Hart.*, from N.W. Ecuador. The back, upper wing-coverts, sides of the head and throat are glossy metallic steel-blue in the Colombian skins, dull greenish blue or bottle-green in those from Central America, and bright purple-blue, inclining to violet, in *purpurascens*. Two skins of the last named form† have very little, or no white at all, on the outermost rectrix, while in the specimens from Chiriqui, Panama, and Bogotá a large portion of the inner web is white. As, however, the male from Noanama agrees, in that respect, with *purpurascens*, much importance cannot be laid upon this character.

The type of *E. fulvicrissa* in the British Museum, said to be from Santa Marta, where, however, recent travellers did not meet with the species, is to be examined in order to ascertain whether it belongs to the Colombian or Veraguan race.

28. *EUPHONIA XANTHOGASTER CHOCOENSIS* Hellm.

[*Euphonia xanthogaster* Sundevall, Vetenskaps Akad. Handl. 1833, p. 310, pl. 10. fig. 1 (= ♂ ad.) (1834.—“Brazil”).]

Euphonia xanthogaster chocoensis Hellmayr, Rev. Franç. d'Orn. no. 22, p. 23 (1911.—Rio Cajón, W. Colombia).

No. 2015. ♂ ad. Noanama: 26.viii.08.—Wing 61; tail $35\frac{1}{2}$; bill $7\frac{1}{3}$ mm.

Nos. 2235, 2236 ‡. ♂ ♂ ad. Rio Cajón: 3.xi.08.—Wing 58, 59; tail 33, 34; bill 8 mm.

Nos. 2086, 2176. ♀ ♀ ad. Sipí: 16.ix., 10.x.08.—Wing 56, 57; tail 30, 31; bill $7\frac{1}{2}$ –8 mm.

“Iris black (♂), dark brown (♀), feet dark grey (♂), grey (♀), bill black, mandible blue.”

* Novit. Zool. viii. p. 377 (1901.—Pambilar, N.W. Ecuador; type in Tring Museum).

† The type from Pambilar, and another from San Javier, both in the Tring Museum.

‡ Type of subspecies.

This new subspecies is most nearly allied to typical *E. xanthogaster*, from Brazil, Peru and Ecuador, but differs in its generally smaller size, especially shorter and smaller bill. The males, too, have the underparts much clearer chrome-yellow, without any trace of the orange tinge which is always well pronounced along the middle line in the eastern race; the females also may be distinguished by the nearly pure cinereous instead of buffy grey colour of the throat and breast, and by having the middle of the abdomen much paler buffy. Forehead and crown, in the males, are clear chrome-yellow, as in average specimens of *xanthogaster*.

E. xanthogaster brevirostris Bonap. *, from Bogotá, is much larger (wing 64-65; tail 38-40; bill 9 mm.), has the foreneck and middle of the belly tinged with orange, and the occiput of a deep brownish orange colour. *E. x. brunneifrons* Chapm. †, from South-eastern Peru, is of the same size as *brevirostris*, but the crown is still darker, dull orange rufous.

The new form has been compared with large series of the various races. Besides the thirteen specimens in the Munich Museum, I had before me twelve from the Berlepsch Collection, and three belonging to the Vienna Museum.

29. CHLOROCHRYSA NITIDISSIMA Schl.

Chlorochrysa nitidissima Scater, P. Z. S. 1873, p. 728 (1874.—Antioquia); idem, Ibis, 1875, p. 466, pl. x.; Scater & Salvin, P. Z. S. 1879, p. 498 (Jerico, Antioquia).

No. 3757. ♂ imm. Siató, Rio Siató: 16.ix.09.—Wing 67; tail 44; bill 12 mm.

No. 3745. ♀ imm. Pueblo Rico: 9.ix.09.—Wing 67; tail 43; bill 13 mm.

“Iris brown, feet grey, bill black.”

This species was discovered by the late T. K. Salmon at Jerico, south of Medellín, on the left side of the Cauca River, in the Western Cordillera of Colombia. Dr. Scater described and figured the adult male. Specimens transmitted by the late J. H. Batty from Riolima (Cauca Valley) agree perfectly with the original description.

The immature male and female differ in lacking the lemon-yellow interscapulum (which is mainly green with but a faint yellowish tinge) and in having the middle of the belly dull grey instead of black. Moreover, the general colour is not so bluish.

C. nitidissima is apparently restricted to the Western Cordillera of Colombia, and found only at altitudes above 5000 feet.

30. CALOSPIZA JOHANNÆ Dalmas.

Calliste johannæ Dalmas, Bull. B. O. C. xi, p. 36 (1900.—El

* *Euphonia brevirostris* Bonaparte, Rev. Mag. Zool. (2) iii, p. 136 (1851; ex Columbia).

† *Euphonia xanthogastra brunneifrons* Chapman, Bull. Amer. Mus. N. H. xiv, p. 226 (1901.—Inca Mines, S.E. Peru).

Paillon, near Buenaventura, Chocó, W. Colombia); Sclater, Ibis, 1901, p. 597, pl. xii. fig. 2 (Paramba, N.W. Ecuador).

No. 2698. ♂ ad. Tadó, 7.vi.09.—Wing 73; tail 50; bill $10\frac{1}{2}$ mm.

No. 2388. ♀ ad. Nóvita: 10.xii.08.—Wing 67; tail 46; bill 10 mm.

No. 2589. ♂ juv. Condoto: 10.iv.09.—Wing $71\frac{1}{2}$; tail 49; bill 9 mm.

"Iris dark brown, feet dark grey, bill black."

Two more specimens, a female and an immature bird, sex not determined, from Tadó, June 1909, are in Mr. Rosenberg's possession.

There is very little difference between male and female, except that the latter is rather smaller and not quite so bright on the head and breast. The young bird lacks the golden hue on the green portions of the plumage, the black of the head and throat is much duller, and the beautiful golden yellow rump of the adults is but faintly indicated by a small patch of dull yellow.

C. johannæ is another species peculiar to the humid forest region of the Pacific coast. Besides the above specimens, and the type (now in the Tring Museum), the only other examples on record are two from Paramba, N.W. Ecuador, procured by one of Mr. Rosenberg's correspondents*.

31. CALOSPIZA RUFIGULA Bonap.

Tanagrella rufigula Bonaparte, Compt. Rend. Acad. Sci. Paris, xxxii. (séance 20. Jan.) p. 77 (1851.—Ecuador, Bourcier coll.); idem, Rev. Mag. Zool. (2) iii. p. 130 (mars 1851,—reprint of orig. descr.).

Calliste rufigularis Sclater, Cat. B. Brit. Mus. xi. p. 107 (Pasto, Colombia †—Lehmann).

No. 2797. ♀ ad. La Selva: 4600 ft., 15.x.09.—Wing 65; tail 44; bill 10 mm.

"Iris dark brown, feet blue-grey, maxilla black, mandible blue."

This bird is identical with typical specimens from Ecuador.

La Selva is the most northerly locality for *C. rufigula* yet known, though an example had already been taken by Mr. Lehmann at Pasto in Southern Colombia, near the Ecuadorian frontier.

32. CALOSPIZA AURULENTA AURULENTA Lafr.

Tanagra (Aglaia) aurulenta Lafresnaye, Rev. Zool. vi. p. 290 (1843.—"Colombie," sc. Bogotá).

Calliste aurulenta Sclater & Salvin, P. Z. S. 1879, p. 498 (Concordia, Frontino).

* Dr. Sclater's record (Ibis, 1901, p. 597) from Peru is a mistake, *cfr.* Hellmayr, Ibis, 1910, p. 328, footnote †.

† Not Ecuador as stated *l. cit.*

No. 3747. ♀ ad. Pueblo Rico: 5200 ft., 10.ix.09.—Wing 73; tail 48; bill 10 mm.

"Iris dark brown, feet grey, bill black."

We have also several specimens from Rio Lima, 6000 ft., collected by the late J. H. Batty in August 1898. They agree perfectly with typical Bogotá skins, while birds from Western Ecuador are *generally* slightly paler on the head and belly.

C. aurulenta sclateri Lafr. replaces it in the Eastern Cordillera of Colombia. It is known to me only from Bogotá specimens.

33. CALOSPIZA ICTEROCEPHALA Bonap.

Calliste icterocephala Bonaparte, Compt. Rend. Ac. Sci. Paris xxxii. (séance 20. Jan.) p. 76 (1851.—Ecuador, Bourcier coll.); Selater, Contrib. Orn. 1851, part ii. April, p. 53, pl. lxx. fig. 1 (the type stated to have been obtained in the valley of Punta Playa, south of Quito); Selater & Salvin, P. Z. S. 1879, p. 498 (Frontino).

Nos. 2825, 2837. ♀ ♀ ad. Pueblo Rico: 2, 6.xi.09.—Wing 71, 69; tail 45, 46; bill 11 mm.

"Iris dark brown, feet grey, bill black."

Agreeing with specimens from Ecuador and Chiriqui. *C. icterocephala* has a wide range, extending from Costa Rica to Western Ecuador. I am unable to detect differences, either in size or in colour, between skins from various localities.

34. CALOSPIZA LAVINIA LAVINIA Cass.

Calliste lavinia Cassin, Proc. Acad. N. Sci. Philad. x. p. 178 (1858.—"Isthmus of Darien, New Grenada").

C. lavinie Cassin, Proc. Ac. N. Sci. Philad. 1860, p. 142 ("Camp Toucey, in the mountains of the Rio Truando"—one ♂ imm.); idem, l. c. 1864, p. 286, pl. i. fig. 1 (figure of type).

C. emiliae Dalmas, Bull. B. O. C. xi. p. 35 (1900.—San José and El Paillon, near Buenaventura, W. Colombia); Selater, Ibis, 1901, p. 596, pl. xii. fig. 1 (S. Javier, Rio Cachabé, N.W. Ecuador); cfr. Hellmayr, Rev. Frang. d'Orn. no. 11, 1910, p. 161-162 (crit.).

Nos. 2149, 2159. ♂ ♂ ad. Sipi: 2, 5.x.08.—Wing 67, 68; tail 43, 44; bill 10 mm.

Nos. 2183, 2190. ♂ ♂ juv. Sipi: 12, 14.x.08.—Wing 65; tail 44; bill $9\frac{1}{2}$ mm.

No. 2191. ♀ ad. Sipi: 14.x.08.—Wing 63; tail 42; bill $9\frac{1}{2}$ mm.

"Iris light brown, feet grey, maxilla dark, mandible lighter brown."

In addition, the Munich Zoological Museum possesses one adult, one young male and two females, from San José, near Buenaventura, 600 feet alt., which were formerly in Comte de Dalmas' collection and formed part of the typical series of *C. emiliae* Dalm. As pointed out by me in Revue Frang. d'Orn.

No. 11, p. 161-162, the blue-throated form is, however, the true *C. lavinia* of Cassin, while the birds inhabiting Veragua and Costa Rica will have to stand as *C. l. dalmasi* Hellm. *C. l. lavinia* ranges from Darien through Western Colombia to N.W. Ecuador, whence the Tring Museum received several specimens, obtained by Mr. G. Flemming at San Javier, on the banks of the Rio Cachabi. It may be mentioned that the same institution possesses also an adult male, taken by Mr. W. F. H. Rosenberg in 1895 at Juntas, Rio Dagua.

35. *CALOSPIZA GYROLOIDES GYROLOIDES* Lafr.

Aglæa gyroloides Lafresnaye, Rev. Zool. x. p. 277 (1847—new name for *Aglæa peruviana* (nec *Tanagra peruviana* Desmarest) Swainson, Anim. in Menag. 1838, p. 356: "Peru"—errore! we substitute *Colombia*).

Calospiza gyroloides deleticia Bangs, Proc. Biol. Soc. Wash. xxi. p. 160 (1908.—San Antonio, W. Colombia, 5800 ft.).

Calliste gyroloides Wyatt, Ibis, 1871, p. 325 (Mountain chain between Bucaramanga and the Magdalena); Berlepsch, Journ. f. Orn. 1884, p. 289 (Bucaramanga); Sclater & Salvin, P. Z. S. 1879, p. 499 (Concordia, 6000 ft.; Remedios, 2360 ft.).

No. 632. ♂ ad. Jiménez, 1600 ft.; 6.viii.07.—Wing 81; tail 55; bill $11\frac{1}{2}$ mm.

Nos. 2838, 3754. ♂ ♂ ad. Pueblo Rico, 5200 ft.; 6.xi., 14.ix.09.—Wing $78\frac{1}{2}$; 82; tail 54, 57; bill 12 mm.

No. 3766. ♂ ad. Siató, Rio Siató, 5200 ft.; 22.ix.09.—Wing 79; tail 54; bill 12 mm.

Nos. 3753, 3767. ♀ ♀ ad. Siató, Pueblo Rico: 13, 22.ix.09.—Wing 74, 75; tail 52, 51; bill $11\frac{1}{2}$ mm.

"Iris dark brown, feet leaden grey, bill black."

This series as well as other specimens from Rio Lima (Cauca Valley, 5000 ft.), Bucaramanga and Bogotá bear out the character claimed by Mr. Bangs for his *deleticia*, viz., all have the lesser wing-coverts green like the remainder of the wing. Unfortunately, however, this form is the true *gyroloides*, as may be easily seen on referring to the original description. Lafresnaye's name was proposed as a mere substitute for the preoccupied term *peruviana* of Swainson, who expressly says: "*shoulder-coverts green*, instead of *golden yellow*." The habitat assigned to *peruviana* by Swainson—Lafresnaye does not trouble himself with localities—is, of course, erroneous since Peruvian birds, as will be shown hereafter, possess a very large, golden yellow shoulder patch. Swainson's type specimen is more likely to have come from the highlands of Colombia, to which the green-shouldered race appears to be confined. While I cannot, therefore, agree with Mr. Bangs in the application of the name *gyroloides*, yet this author is perfectly right in considering the Colombian and Central American races as distinct. The study of the fine series in the Munich Museum, together with other specimens lent by Count Berlepsch, Dr. Hartert, and Dr. von Lorenz of Vienna, shows that there

are at least three geographical forms of *C. gyroloides* to be distinguished. In the following lines I give a short resumé of their characters which, I hope, will enable ornithologists to identify the various subspecies.

(a) *C. GYROLOIDES GYROLOIDES* Lafr.

Hab. Mountains of Western and Central Colombia: Jiménez (1600 ft.), Pueblo Rico, Siató (5200 ft.), San Antonio (5800 ft.), province of Chocó (*Palmer*); Rio Lima (5000 ft.), Cauca (*Batty*); Concordia (6000 ft.), Remedios (2360 ft.), Antioquia (*Salmon*); Bucaramanga (Minlos, *Wyatt*); Fusagasuga (6000 ft.: *Wheeler*)*; also found in Bogotá collections.

Adult. Bill large and heavy; rufous chin spot immediately followed by the cærulean blue colour of the under parts; rufous crown without any yellow border behind or with but a very narrow, yellowish line; *lesser upper wing-coverts green* like the median and greater ones, sometimes slightly more yellowish green than the latter, but never yellow.

Specimens from different localities present the following measurements:—

Four adult males from Chocó: Wing $78\frac{1}{2}$ –82; tail 54–57; bill $11\frac{1}{2}$ –12 mm.

One adult male from Rio Lima, Cauca: Wing 82; tail 54; bill 12 mm.

One adult male from Bucaramanga (Mus. Berlepsch): Wing 78; tail 53; bill 11 mm.

Seven adults from Bogotá coll.†: Wing 75–82; tail 52–56; bill $11\frac{1}{2}$ –12 mm.

Two females from Chocó: Wing 74, 75; tail 52, 51; bill $11\frac{1}{2}$, 12 mm.

(b) *C. GYROLOIDES BANGSI*, subsp. n.

Hab. Costa Rica, Chiriqui, and apparently Western Ecuador.

Type in the Zoological Museum of Munich, No. 09.5340. ♂ ad. Boquete, Chiriqui, 3500 feet, December 17, 1904. H. J. Watson coll.

Adult. Like *C. g. gyroloides* with no or very little green, between the rufous chin-spot and the cærulean blue colour of the under parts; yellowish border to posterior edge of rufous cap absent or but faintly indicated: bill large and heavy; but differs in having the *anterior lesser wing* (or shoulder) *coverts pale golden yellow*, this colour forming a conspicuous patch on the wing, abruptly contrasting with the green of the remaining portion.

Specimens from different localities measure as follows:—

Six adult males from Chiriqui: Wing 78–80; tail 54–55; bill 12 mm.

* Mr. Rosenberg tells me that there are two specimens of the green-shouldered race from this locality in the British Museum, and that Salmon's two skins from Antioquia belong also here.

† Four in the Munich Museum, three in the collection of Count Berlepsch.

One adult male from Costa Rica (Naranjo): Wing 81; tail 56; bill $13\frac{1}{2}$ mm.

Eight adult males from Western Ecuador (Intag, S. Nicolas, Gualaes): Wing 78-80; tail 52-58; bill $12-12\frac{1}{2}$ mm.

Five adult males from Paramba, N.W. Ecuador: Wing 75-79; tail 52-55; bill 12 mm.

Remarks. It is a curious fact that the birds from Western Ecuador should belong to the Central American race, and not to *C. g. gyroloides* which is found in the neighbouring republic of Colombia. However, all of the many specimens—nearly thirty from Paramba, and eleven from other localities in Western Ecuador—which I have been able to examine showed the pale golden yellow shoulder-spot well-developed, thereby differing very markedly from the Colombian form with its uniform green wings. Although the majority of the Ecuadorian skins have the blue of the rump rather lighter, and the top and sides of the head somewhat clearer rufous, yet many specimens are quite indistinguishable from the Chiriqui ones. I do not, of course, believe in a discontinuous distribution, and fully expect that *C. g. bangsi* will be found to exist in the Colombian coast district, having thus an uninterrupted range from Western Ecuador to Chiriqui, while *C. g. gyroloides* is most probably confined to the high, open country of the interior. This view is also shared by Mr. W. F. H. Rosenberg, who has a considerable knowledge of the local distribution of birds in those western districts.

The single Costa Rica male has a decidedly longer bill than any other example examined by me.

I have named the new form after Mr. Outram Bangs, of Boston, in recognition of his numerous important contributions to the ornithology of tropical America.

(c) *C. GYROLOIDES CATHARINÆ*, subsp. n.

Hab. Upper Amazonia: from the eastern slopes of the Andes in Colombia (Rio Meta*) and the banks of the Rio Negro (Marabitanas, Rio Xié) through Eastern Ecuador and Peru to Northern Bolivia (Yuracarès).

Type in the Zoological Museum of Munich, No. 11,399 ♂ ad. Chaquimayo Carabaya, S.E. Peru, 3000 feet, 29.viii.1910. H. & C. Watkins coll. no. 327.

Adult. Smaller, with a much weaker, slenderer bill; rufous cap bordered behind by a very distinct, golden yellow band, from 2 to 3 mm. wide; upper throat dark green, separating the rufous chin-spot from the blue foreneck; the whole of the lesser and the adjoining median upper wing-coverts deep orange golden, forming a very large, bright shoulder-patch. This patch is about twice as large as in *C. g. bangsi*, and of a much deeper, more orange golden tinge.

* According to Mr. Rosenberg, the British Museum has four adult birds of this form from the Rio Meta (800-1500 ft.; Wheeler coll.) and several others obtained by Buckley in Eastern Ecuador.

Specimens from different localities measure as follows:—

Three adult males from Chanchamayo (C. Peru): Wing 75–77; tail 49–53; bill 10–11 mm.

One adult male from N. Peru (Huayabamba).—Wing 73; tail 48; bill 11 mm.

Four adult males from S.E. Peru (Marcapata): Wing 73–76; tail 52–54; bill 11 mm.

Three adult males from Upper Rio Negro*: Wing 70–72; tail 47–49½; bill 10 mm.

Two adult males from the Rio Putumayo, S.E. Colombia (Mus. Berlepsch): Wing 70½, 71; tail 49, 50; bill 10–10½ mm.

Two adult males from Bogotá collections: Wing 75, 76; tail 53, 54; bill 10½, 11 mm.

Remarks.—These fifteen examples differ very conspicuously from *C. g. bangsi* in the characters given above. The three from the upper Rio Negro and one from the Putumayo have the head of a deep chestnut-brown (instead of cinnamon-rufous) colour, but the second specimen from the Rio Putumayo and the two Bogotá skins agree with the Peruvian ones. The dimensions are also rather variable, though apparently not connected with any particular geographical area.

I have named this well-characterized new form after my wife, who takes considerable interest in ornithology and has materially helped me in the preparation of this report.

36. CALOSPIZA PALMERI Hellm.

Calospiza palmeri Hellmayr, Rev. Franç. d'Ornith. No. 4, p. 49 (1909.—Sipi, W. Colombia); idem, Ibis, 1910, p. 330, pl. v.

Nos. 2164, 2166†, 2167, 2186. ♂♂ ad. Sipi, Rio Sipi: 7, 13.x.08.—Wing 80½–83; tail 55½–60; bill 10–11 mm.

No. 2165. ♀ ad. Sipi: 7.x.08.—Wing 76½; tail 50; bill 11 mm.

“Iris dark brown, feet and bill black.”

This fine new bird was fully described by me *l. c.* and is faithfully depicted on plate v. in ‘The Ibis,’ 1910.

Mr. Palmer has not succeeded in getting additional specimens of this Tanager.

37. CALOSPIZA LARVATA FANNY Lafr.

Aglaia Fanny Lafresnaye, Rev. Zool. x. p. 72 (1847—“in Nova Grenada” (Delattre)—sc. Buenaventura, W. Colombia.‡)

Calliste francesce Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 142 (Turbo, N.W. Colombia).

* Two from the Rio Xié, June 1831, one from Marabitanas, March 1831, obtained by J. Natterer, Vienna Museum [= *Calliste gyroloides* Pelzeln, Orn. Bras. iii. 1869, p. 207].

† Type of species.

‡ The type is in the Museum of the Academy of Natural Sciences in Philadelphia (*cf.* Stone, Proc. Acad. N. Sci. Philad. v. 1899, p. 51), and not in Baron de Lafresnaye's Collection, as erroneously stated by Ridgway (Bull. U. S. Mus. no. 50, pt. ii. p. 50).

C. larvata francescae Hartert, Nov. Zool. v. 1898, p. 482 (Cachabi, N.W. Ecuador).

Calliste larvata (errore, nec Dubus) Sclater & Salvin, P. Z. S. 1879, p. 499 (Remedios, Antioquia).

Nos. 2050, 2062. ♂ ♂ ad. Noanama: 2, 4.ix.08.—Wing 69; tail $47\frac{1}{2}$ –49; bill 10 mm.

Nos. 2063, 2199, 2200. ♀ ♀ ad. Noanama: 4.ix., 18, 19.x.08.—Wing 65–68 $\frac{1}{2}$; tail 44–47; bill 10 mm.

No. 2408. ♀ ad. Növita: 17.xii.08.—Wing 65 $\frac{1}{2}$; tail 46; bill 11 mm.

No. 2032. ♂ juv. Noanama: 28.viii.08.

“Iris dark brown, feet and bill black.”

This is the true *C. l. fanny* which was originally described from specimens obtained by Delattre in the same district of Western Colombia. The comparison of these birds with the large series in the Munich Museum clearly proves that the Central-American form has been wrongly referred to *C. l. fanny* by Sclater, Ridgway, and others. *C. l. fanny* as represented by specimens from Western Colombia and N.W. Ecuador (which are exactly similar) is an exceedingly well characterized race. The greater upper wing-coverts and the remiges are either uniform black or show only the faintest trace of greenish fringes in their apical half; the lower back and rump are very pale sky-blue; the blue frontal patch is very strongly developed, reaching as far as the posterior edge of the eye; the flanks are washed with pale sky-blue, without any purple-blue admixture; the bill is small and slender. Birds from Chiriqui and S.W. Costa Rica (Guana-caste, Pozo Azul de Pirris), however, differ at a glance in having the greater wing-coverts and remiges very distinctly margined with pale green, and the flanks much more extensively and darker blue, with a strong purplish blue tinge anteriorly. Moreover, the blue frontal patch is much more restricted, never reaching further back than to above the middle of the eye, and the bill is larger and stouter. In all of these points they agree with *C. l. larvata* Dubus*, of which we have a fair series from Guatemala and Eastern Costa Rica (Carrillo), but may easily be distinguished from that form by their coppery-golden, instead of deep coppery reddish-brown throat, much paler blue cheeks with very little purplish tinge, and slightly paler blue rump.

C. l. fanny is restricted to the forest-belt bordering the Pacific coast, ranging from N.W. Ecuador (Cachabi, S. Javier, Pambilár) to Turbo, on the Gulf of Uraba, N. Colombia.

38. CALOSPIZA RUFICERVIX RUFICERVIX Prév. & Des Muirs.

Tanagra ruficervix Prévost & Des Murs, Voyage de la Vénus, Atlas, Oiseaux, pl. v. fig. 1 (1846—no locality).

T. (Calliste) rufivertex iidem, l. c., Zool. (text), V, 1, p. 212

* *Calliste larvata* Dubus, Esquiss. Ornith. pl. 9 (1845(?).—Tabasco, S.E. Mexico).

(1855.—The type stated to be from Guatemala, which is doubtless a mistake).

Calliste ruficervix Scater & Salvin, P. Z. S. 1879, p. 499 (Concordia).

Nos. 2813, 2824. ♀ ♀ ad. Pueblo Rico: 20, 26.x.02.—Wing 72, 70; tail 48; bill 10 mm.

"Iris dark brown, feet grey, bill black."

The Munich Zoological Museum also possesses an adult male from Rio Lima, 5000 ft., taken in August 1898 by the late J. H. Batty.

The birds from Western Colombia are in every respect similar to others from Bogotá and Western Ecuador in our collection.*

C. r. ruficervix is found only in Colombia (Western Cordillera and Bogotá-coll.) and Western Ecuador (Pallatanga, Cayandeled), living at rather high altitudes. In Eastern Ecuador (Machay, Napo) it is represented by the well-characterized *C. r. taylori* Tacz. & Berl. †, while, in Peru and Northern Bolivia, *C. r. fulvicervix* Sc. & Salv. ‡ takes its place. Of this last-named form, the Munich Museum possesses specimens obtained by Mons. G. A. Baer at Nuevo Loreto, Northern Peru, in June 1900.

39. CALOSPIZA LABRADORIDES Boiss.

Tanagra (Aglaia) labradorides Boissonneau, Rev. Zool. iii. p. 67 (1840.—Santa-Fé-de-Bogotá).

Calliste labradorides Scater & Salvin, P. Z. S. 1879, p. 499 (Concordia, Santa Elena).

No. 3751. ♀ ad. Pueblo Rico: 9.ix.09.—Wing 65; tail 47; bill — mm.

"Iris dark brown, feet grey, bill black."

We have also an adult male procured by J. H. Batty at Rio Lima, 5000 ft., in August 1898. The birds from the Western Cordillera agree perfectly with a series of Bogotá skins.

C. labradorides is peculiar to the mountains of Colombia.

40. BUTHRAUPIS MELANOCHLAMYS Hellm.

B. melanochlamys Hellmayr, Bull. B. O. C. xxv. no. clxi. p. 112 (June 1910.—La Selva, W. Colombia).

No. 2796. ♀ ad. La Selva, Rio Jamaraya, 4600 ft., 15.x.09. *Type of species.* No. 10.2378. Coll. Zoological Museum, Munich.

Head all round, back and scapulars deep black, with a faint silky gloss; lower rump and upper tail-coverts rather dull indigo-

* None of the many specimens I have examined showed any trace of the white auricular spot or any white on the lesser wing-coverts, characters given by Dr. Scater for his *Calliste leucotis* (Contrib. to Ornith. 1851, pt. ii. April, p. 58.—Ecuador).

† *Calliste taylori* Taczanowski & Berlepsch, P. Z. S. 1885, p. 75 (1885.—Machay, E. Ecuador).

‡ *Calliste fulvicervix* Scater & Salvin, P. Z. S. 1876, p. 354, pl. xxx. fig. 1 (Aug. 1876.—Tilotilo, N. Bolivia.)

blue (Valette's Code des Couleurs, no. 417); lesser and median upper wing-coverts uniform bright indigo-blue (in shade between nos. 411 and 412 of Valette's Code), forming a large pale blue shoulder-patch; greater series dusky, on the outer web washed with dull bluish; primary coverts, remiges and rectrices blackish, narrowly fringed with dull bluish along outer margin. Below: throat and sides of breast deep black, like the back; flanks duller and inclining to blackish slate-colour; rest of under parts bright saffron-yellow, passing into a deeper, more orange tinge on the middle of the chest. Axillaries pale yellow, under wing-coverts yellowish white.

Bill uniform black. "Iris brown, feet black."

Wing 90; tail 53; bill $15\frac{1}{2}$ mm.

Mr. Palmer obtained a single specimen of this distinct species on the San Juan slopes of the Western Cordillera. It belongs to that section embracing *B. arcæi* Scl. & Salv.* and *B. rothschildi* Berl.†, but differs conspicuously in coloration. The most important characters of *B. melanochlamys* are the bright, pale blue shoulder-patch, altogether absent in both of its allies, and the deep black colour of the head, mantle, and scapulars, without any bluish tinge. *B. arcæi* resembles it in having the breast and belly bright yellow, but the sides and flanks, instead of being extensively uniform deep black, are merely clouded with dusky, and the upper parts as well as the throat are strongly glossed with dark purplish blue. *B. rothschildi*, from the foot-hills of North-Western Ecuador, has, like the new species, the head and throat deep black; however, the back, scapulars, upper wing- and tail-coverts are conspicuously glossed with purplish blue, while the under parts, with the exception of an orange-yellow patch on the foreneck, and the lemon-yellow anal region and under tail-coverts, are black, with a more or less distinct purple-blue sheen.

The bill is deep black in all three species which eventually will prove to be geographical representatives. Their range is singularly restricted:—

(a) *B. arcæi* Scl. & Salv. inhabits the Cordillera del Chucú, Veragua.

(b) *B. melanochlamys* Hellm. is found in the Western Cordillera of Colombia, on the sources of the San Juan River.

(c) *B. rothschildi* Berl. is met with in the foot-hills of North-Western Ecuador: Cachabi (450 ft.), Río Pichiyacú (500 ft.), etc.

41. BUTHRAUPIS AUREOCINCTA Hellm.

B. aureocincta Hellmayr, Bull. B. O. C. xxv. no. clxi. p. 111 (June 1910.—Tatamá Mountain, W. Colombia).

No. 3487. ♂ ad. Tatamá Mountain, Chocó, 6700 feet, 8.x.09. *Type of species*. No. 10.2377. Coll. Zoological Museum, Munich.

♂ ad. Top and sides of the head, and nape deep black, with the

* P. Z. S. 1869, p. 439, pl. xxxi. (Cordillera del Chucú, Veragua).

† Bull. B. O. C. vii. p. iii (Oct. 1897.—Cachabi, N.W. Ecuador); Hartert, Nov. Zool. v. 1898, p. 482, pl. ii. fig. 2.

exception of a broad, bright saffron-yellow band which starts from above the eye and descends the sides of the neck where it joins the yellow malar stripe. Back bright olive-green; upper wing-coverts dull indigo-blue, those of the greater series dusky on the inner web; primary coverts and remiges black, edged with dull indigo-blue, the innermost secondaries washed with the same colour on both webs; rectrices blackish, exteriorly broadly margined with bright olive-green. Cheeks and malar region bright saffron-yellow; large chin-spot pale yellow, some of the feathers with slight dusky edges; throat and sides of the foreneck black, the feathers of the former with half-concealed, subterminal spots of pale yellow; a large, bright golden-yellow patch in the middle of the foreneck; remainder of under parts olive-green, lighter and more yellowish than the back; under tail-coverts lemon-yellow, with the basal half olive-green. Axillaries dusky, tipped with greenish; under wing-coverts greyish white.

"Iris brown, feet dark brown, maxilla black, mandible yellow."

Wing 93; tail 60; bill 14 mm.

This species, of which Mr. Palmer sent only a single adult bird, is most nearly related to *B. edwardsi* Elliot.* The two species agree in the colour of the back, wings and tail, in having the breast and abdomen olive-green, with a large, golden-yellow patch on the foreneck, also in the shape and coloration of the bill; but *B. edwardsi* may be distinguished at a glance by having the sides of the head uniform pale blue, without any yellow or black.

B. aureocincta is known only from the Tatamá Mountain, on the sources of the San Juan River, in the Western Cordillera of Colombia.

B. edwardsi is an inhabitant of the high mountains of Southern Colombia and Northern Ecuador. The type, in the Paris Museum, was brought by M. Triana from an uncertain locality in "New Grenada." A single specimen was obtained by Prof. Orton at Chillo, on the western slope of the volcano Antisana, 10,000 ft. alt.†, Ecuador, and the British Museum received three examples from Pasto, S. Colombia‡, through Mr. Lehmann. Count Berlepsch possesses a female picked out from a lot of Quito-skins. There is, in the United States Museum at Washington †, a skin said to be from Esmeraldas, N.W. Ecuador, but this locality is, no doubt, incorrect.

42. COMPSOCOMA NOTABILIS Jard.

Tanagara (sic) *notabilis* Jardine, New Edinburgh Philos. Journ. (n. s.) ii. p. 119 (July 1855.—Eastern Cordillera, Ecuador. W. Jameson coll.).

Nos. 3785, 3786. ♂♂ ad. Tatamá Mountain, 6700 ft., 8.x.09.—Wing 99, 100; tail 82, 83; bill 19 mm.

"Iris brown, feet black, maxilla black, mandible blue."

* Nouv. Arch. Mus. Paris, i. Bull. p. 77, pl. iv. fig. 2 (1865.—"Nouvelle Grenade").

† Salvin, Ibis, 1874, p. 307.

‡ Not Ecuador, as stated in the Cat. B. Brit. Mus. xi. p. 150.

The specimens correspond to the original description, and to the figure in P. Z. S. 1855, plate xci.

So far as I know, this beautiful species has not been recorded before from Colombia, and was reported only as an inhabitant of the highlands of Northern Ecuador.

43. TANAGRA PALMARUM MELANOPTERA Sel.

[*Tanagra palmarum* Wied, Reise nach Brasil. ii. p. 76 (1821.—Canavieras, Bahia.)]

T. melanoptera (Hartlaub MS.) Sclater, P. Z. S. 1856, p. 235 (Jan. 1857.—Eastern Peru, etc.).

T. palmarum (nec Wied) Sclater & Salvin, P. Z. S. 1879, p. 500 (Remedios).

T. p. melanoptera Berlepsch, Journ. f. Orn. 1884, p. 291 (Bucaramanga).

Nos. 2499, 2650, 2682. ♂♂ ad. Nóvita: 28.i.09; Tadó: 18.v., 1.vi.09.—Wing 92; tail 70–72; bill 13 mm.

No. 2805. ♂ ad. Loma Hermosa, 4180 ft., 23.x.09.—Wing 94; tail 73; bill 13 mm.

Nos. 2424, 2649, 2716. ♀ ad., ♀ jr., ♂ juv. Nóvita: 22.xii.08; Tadó: 18.v., 18.vi.09.—Wing 89–90; tail 72, 70, 67; bill 12½–13 mm.

“Iris dark brown, feet grey, bill black.”

The adult birds agree with topotypical skins from Northern Peru and others from Eastern Ecuador (Napo), Venezuela, Trinidad, etc., except that the top of the head is of a paler, duller yellowish olive. In this respect they resemble a series of Bogotá skins. It must be mentioned, however, that two or three from Bogotá have the cap quite as bright olive-yellow as the Peruvian ones. More information about the geographical distribution of these forms is required before any further separation can be attempted.

T. p. violilavata Berl. & Tacz.,* from Western Ecuador, is very different from the Colombian birds. It has both the upper and lower parts much more strongly suffused with violet, and lacks the olive-yellowish cap, the pileum being bluish like the back.

44. RAMPHOCELUS ICTERONOTUS Bonap.

Ramphocelus icteronotus Bonaparte, P. Z. S. 1837, p. 121 (1838, June.—loc. ign., type in Paris Museum); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 141 (Turbo, Rs. Atrato and Truando).

Rhamphocelus icteronotus Sclater & Salvin, P. Z. S. 1879, p. 501 (Remedios, Neehe).

Nos. 1969, 2207, 2407. ♂♂ ad. Guineo: 5.viii.07; Nóvita: 17.xii.08; Noanama: 21.x.08.—Wing 85–87; tail 72–78; bill 15–16 mm.

No. 2433. ♂ vix ad. Nóvita: 24.xii.08.—Wing 85; tail 75; bill 15 mm.

* P. Z. S. 1883, p. 546 (1883.—Chimbo, S.W. Ecuador).

No. 2110. ♂ imm. Sipi: 23.ix.08.—Wing 85; tail 77; bill 16 mm.

Nos. 1956, 2228, 2240. ♀ ♀. San Joaquin, 1.viii.08; Rio Cajón: 2, 5.xi. 08.—Wing 79–82; tail 71–76; bill 15–16 mm.

“Iris red, dark brown (no. 2433), feet blue-grey or blue, bill blue.”

The Munich Museum also possesses specimens obtained by the late J. H. Batty on the Rio Guapi, 200–300 feet alt.

R. icteronotus ranges from Veragua to S.W. Ecuador (district of Guayaquil)*, frequenting the forest-region, from sea-level up to about 3000 feet.

45. *PIRANGA RUBRA RUBRA* Linn.

Fringilla rubra Linnaeus, Syst. Nat. x. p. 181 (1758,—based on Catesby, Nat. Hist. Carolina etc. i. p. 56, pl. 56; *Carolina*, Virginia).

Pyrranga æstiva Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 140 (Turbo); Selater & Salvin, P. Z. S. 1879, p. 502 (Concordia, Frontino).

Nos. 2203, 2213. ♂ ♂ ad. Noanama, 100 ft., 20, 22.x.08.—Wing 94, 95; tail 74, 76 mm.

No. 2223. ♂ ad. Rio Cajón: 30.x.08.—Wing 96; tail 73 mm.

Nos. 2817, 2823, 2830. ♂ ♂ ad. Pueblo Rico, 5200 ft., 28, 30.x., 3.xi.09.—Wing 93, 96, 99; tail 72, 74, 76 mm.

No. 2204. ♂ juv. Noanama: 20.x.08.

Nos. 2224, 2251, 2390. ♀ ♀. Nóvita: 9, 11.xii.08; Rio Cajón: 30.x.08.—Wing 92–93 mm.

“Iris dark brown, feet grey or purplish grey, maxilla yellowish brown or horn-colour, mandible yellowish brown, yellow, or grey.”

A common winter visitor to South America.

46. *PHÆNICOTHRUPIS CRISTATA* Lawr.

Phænicothraupis cristata Lawrence, Ann. Lyc. N. H. N. Y. xi. p. 70 (Feb. 1875.—Bogotá).

Phænicothraupis cristata Selater & Salvin, P. Z. S. 1879, p. 502 (Frontino, Antioquia); Bangs, Proc. Biol. Soc. Wash. xxiii. p. 75 (Naranjito, R. Dagua).

Nos. 3778, —. ♂ ♂ ad. La Selva, 4600 ft., Oct. '09.—Wing 97, 98; tail 85, 89; bill 18, 19 mm.

No. — (not numbered). ♂ ad. Pueblo Rico, 5200 ft., Nov. '09.—Wing 98; tail 89; bill 17½ mm.

No. — (not numbered). ♂ ad. Loma Hermosa, 4150 ft., Oct. 20, '09.—Wing 100; tail 90; bill (damaged) mm.

Nos. 2739, 2829. ♀ ♀ ad. Pueblo Rico: viii, 3.xi.09.—Wing 94, 95; tail 86; bill 18, 20 mm.

* Ridgway (Bull. U.S. Mus. no. 50, pt. ii. p. 114) erroneously included “Central Peru” in the habitat of this species. Palmal whence Taczanowski (P. Z. S. 1877, p. 332) recorded a couple, is *not* in Peru, but in the district of Santa Rosa, province of Guayaquil, S.W. Ecuador. *R. icteronotus* does not occur anywhere in Peru.

No. 3752. ♀ juv. Pueblo Rico: 13.ix.09.—Wing 88; tail 81; bill 17 mm.

“Iris brown (adult), grey (juv.), feet brown, bill black.”

The adult males have the back deep vinous red, the upper wing-coverts and outer webs of the quills scarcely duller. The females are smaller; the crest is duller and more of a scarlet red; the throat rather lighter red; the back and wings are much duller, brownish vinaceous; breast and abdomen decidedly paler pink, with the greyish bases of the feathers more plainly showing through, etc.

The young bird has the upper parts dusky brown, with the tail-coverts and rectrices dull testaceous, the lower surface dingy cinnamonous passing into dark brown on throat and foreneck. There is no trace of the red crest, only a few of the crown-feathers are narrowly edged with dull reddish.

P. cristata is peculiar to the mountainous districts of Western Colombia. It is only occasionally met with in Bogotá collections.

47. CHLOROTHAUPIS OLIVACEA Cass.

Orthogonys olivaceus Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 140 (1860.—“Cordilleras Mountains, on the River Truando, New Grenada”); Sclater & Salvin, P. Z. S. 1879, p. 502 (Remedios, Neche).

Chlorothraupis olivacea Hartert, Nov. Zool. v. 1898, p. 483 (Cachabi, N.W. Ecuador).

Nos. 2137, 2232. ♂ ♂ ad. Sipi: 11.x.; Rio Cajón: 2.xi.08.—Wing 92, 94; tail $63\frac{1}{2}$, 65; bill $18\frac{1}{2}$, $19\frac{1}{2}$ mm.

No. 2379. ♂ imm. Névita: 9.xii.08.—Wing 89; tail 63; bill $18\frac{3}{4}$ mm.

Nos. 1962, 2101, 2111, 2123. ♀ ♀ ad. & imm. S. Joaquim: 3.viii.; Sipi: 21, 23, 26.ix.08.—Wing 85, 86, 86, 90; tail 59–60; bill 18–20 mm.

“Iris dark brown, feet blue or dark grey, maxilla black, mandible blue.”

Adult males are dark brownish green above and have the feathers of the pileum broadly centred with blackish; the lower parts are nearly uniform olive-green except the upper throat, which is light yellow. The females are much smaller, lighter green above, and more yellowish green below with the whole throat and middle of foreneck pale yellow; the pileum is uniform olive-green like the back.

C. olivacea is peculiar to the humid forest-district of Western Colombia and N.W. Ecuador.

48. HETEROSPINGUS XANTHOPYGIUS Scl.

Tachyphonus xanthopygius Sclater, P. Z. S. 1854, p. 158, pl. lxi. (Apr. 1855—“in Nova Grenada”; descr. ♀); idem, l. c. 1855, pl. xc. (descr. ♂; Bogotá); Cassin, Proc. Acad. N. Sci. Philad.

1860, p. 142 (Truando; one ♂ adult); Sclater & Salvin, P. Z. S. 1879, p. 503 (Remedios).

Nos. 2357, 2709. ♂ ♂ ad. Nóvita: 1.xii.08; Tadó: 16.vi.09.—Wing 92, 89; tail 68, 65; bill 18 mm.

Nos. 2253, 2358, 2610. ♀ ♀ ad. Nóvita: 9.xi., 1.xii.08; Condoto: 17.iv.09.—Wing 88–90; tail 65–67; bill 16–18 mm.

“Iris dark red, feet dark grey, bill black.”

These birds are identical with Bogotá-skins in the collection of the Munich Museum. Like the latter, the males have a broad scarlet supra-auricular stripe, and the lesser upper wing-coverts bright lemon-colour.

H. xanthopygius ranges from N.W. Colombia (Truando) southwards to S.W. Ecuador, where a specimen was obtained by Dr. Siemiradzki in the vicinity of Chimbo*. In Panama and Eastern Costa Rica it is represented by the nearly allied, and perhaps only subspecifically distinct *H. rubrifrons* Lawr.† Although considered by Salvin‡ to be inseparable from *H. xanthopygius* of Colombia, two birds from Veragua and Chiriqui are so much smaller (wing 78, 80; tail 58 mm.) than any of the numerous (about fifteen) specimens of the southern form, that there can be scarcely any doubt as to their distinctness. Moreover, in *H. rubrifrons* the sexes are alike, the male lacking the scarlet supra-auricular stripe as well as the yellow patch on the lesser wing-coverts. Cfr. Ridgway, Bull. U.S. Nat. Mus. no. 50, pt. ii, pp. 104–105.

49. TACHYPHONUS DELATRII Lafr.

Tachyphonus Delatrii Lafresnaye, Rev. Zool. x. p. 72 (1847.—Buenaventura, W. Colombia).

T. De Lattrei Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 142 (Falls of the Truando).

T. delatirii Sclater & Salvin, P. Z. S. 1879, p. 503 (Remedios, Neche).

No. 1959. ♂ ad. San Joaquín (Buenaventura): 1.viii.08.—Wing 74; tail 64; bill 14 mm.

Nos. 2027, 2064. ♂ ♂ ad. Noanama: 28.viii., 4.ix.08.—Wing 73, 72; tail 65, 63; bill 13, 14 mm.

Nos. 2222, 2238. ♂ ♂ ad. Río Cajón: 30.x., 3.xi.08.—Wing 74, 73; tail 65, 63; bill 13, 14 mm.

Nos. 2094, 2109, 2117, 2139. ♂ ♂ ad. Sipí: 19, 23, 24.ix., 1.x.08.—Wing 71–73; tail 62–64, bill 13–14 mm.

Nos. 2090, 2130, 2163, 2184. ♀ ♀. Sipí: 18, 30.ix., 7, 13.x.08.—Wing 63–67; tail 55–58; bill 12–13 mm.

“Iris dark red, feet and bill black.”

These examples are topotypical, Lafresnaye's type having been

* Berlepsch & Taczanowski, P. Z. S. 1883, p. 547: *Tachyphonus xanthopygius*.

† *Tachyphonus rubrifrons* Lawrence, Proc. Acad. N. Sci. Philad. xvii. p. 106 (1865.—Line of Panama Railroad).

‡ Ibis, 1870, pp. 109–110: *T. propinquus*.

secured by Delattre at Buenaventura, in the Bay of Chocó. Birds from Western Ecuador are absolutely similar.

Skins from Costa Rica (Carrillo etc.) are larger, with a longer and more slender bill; the males are of a duller, more brownish black, and have the vertical crest somewhat deeper orange. They are perhaps subspecifically separable. The locality 'Pasto'* is, no doubt, incorrect, for *T. delatrii* is found only in the lowlands and foot-hills.

50. MITROSPINGUS CASSINII Lawr.

Tachyphonus Cassinii Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 297 (Jan. 1861.—Panama Railroad).

Tachyphonus?—Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 142 (Falls of the Rio Truando).

Eucometis cassini Sclater & Salvin, P.Z.S. 1879, p. 503 (Nèche); Hartert, Nov. Zool. v. 1898, p. 483 (Cachabi, N.W. Ecuador).

Nos. 2612, 2613. ♂ ♂ ad. Condoto: 20.iv.07.—Wing 86, 84; tail 77, 74; bill 18 mm.

"Iris grey, feet black, bill black, mandible grey."

These birds agree, in coloration and size, with others from Costa Rica. Topotypical Panama specimens are not available for comparison.

M. cassinii ranges from Costa Rica through Western Colombia southwards to N.W. Ecuador, whence Mr. Rosenberg's collectors have sent many specimens†. It is an inhabitant of the humid forests of the lowlands and foot-hills, up to about 2000 feet.

51. HEMITHRAUPIS SALMONI Scl.

Dacnis salmoni Sclater, Cat. B. Brit. Mus. xi. p. 27, pl. ii. fig. 2 (1886.—Remedios, Antioquia; = ♀); *cfr.* Hellmayr, Nov. Zool. xiii. 1906, p. 317 (crit.).

Nemosia rosenbergi Rothschild, Bull. B. O. C. vii. p. vi (Oct. 1897.—Cachabi, N.W. Ecuador; = ♂ ad.); Hartert, Nov. Zool. v. 1898, p. 483, pl. ii. fig. 1.

Nos. 2245, 2246, 2321, 2391. ♂ ♂ ad. Nóvita: 7, 21.xi., 11.xii.01.—Wing $67\frac{1}{2}$ –76; tail 50–53; bill $12\frac{1}{3}$ – $12\frac{3}{4}$ mm.

No. 2096. ♂ ad. Near Sipí: 19.ix.08.—Wing 68; tail 50 mm.

No. 2261. ♂ vix ad. Nóvita: 11.xi.08.—Wing 66; tail 49; bill $13\frac{1}{2}$ mm.

Nos. 2324, 2331. ♂ ♂ juv. Nóvita: 21, 24.xi.08.—Wing 65; tail 49, 50; bill $12\frac{1}{2}$, $13\frac{1}{2}$ mm.

Nos. 2323, 2337. ♀ ♀ ad. Nóvita: 21, 25.xi.08.—Wing 57; tail 42, 43; bill 11–12 mm.

"Iris dark brown, feet dark brown (♂ ad.), grey (♂ juv. and ♀); maxilla black, mandible light brown or yellowish pink (♂ ad.), grey (♂ juv. and ♀)."

* Cat. B. xi. p. 215.

† Ridgway (Bull. U.S. Mus. no. 50, pt. ii. p. 169) mentions, as existing in the U.S. National Museum, a female from "Guayaquil," S.W. Ecuador, but this locality requires confirmation.

[Mus. Brit. ♀ imm. Remedios, Antioquia. Type of *D. salmoni*.—Wing 58; tail 42; bill 12 mm.]

The splendid series forwarded by Mr. Palmer leaves no longer any doubt that *Dacnis salmoni* is the female of *N. rosenbergi*. The females from Nóvita agree perfectly with the type in the British Museum, with which they were kindly compared by my friend Dr. Hartert. Moreover, they correspond exactly to a detailed description drawn up by me when in London some years ago. The type of *N. rosenbergi* was obtained at Cachabi, N.W. Ecuador, 450 feet, in November 1896, by Mr. W. F. H. Rosenberg, and is faithfully depicted on the plate quoted above.

The female may be described as follows:—Above dull yellowish olive, pileum rather darker, hind crown somewhat shaded with cinereous; upper wing-coverts like the back; quills dusky, exteriorly edged with yellowish olive; rectrices dusky, washed with pale yellowish olive; sides of the head dull olive; throat and foreneck dingy buff; remainder of under parts buffy white, more purely white along the middle of the abdomen; under tail-coverts light buff; axillaries and under wing-coverts white; distinct margin along the inner web of the remiges olive-yellow. Wings and tail are much shorter than in the adult male, and the bill is likewise shorter, with the lower mandible pale horn-brown instead of whitish.

The young males (nos. 2324, 2331) in coloration resemble the female, but are very nearly as large as the adult males. They show a few orange-yellow feathers on the sides of the head. The mandible is pale brown as in the females.

In structure, *H. salmoni* agrees with *H. chrysomelas* Sel. & Salv. *, from Southern Central America. The females also present the same style of coloration, that of *H. salmoni* being, however, easily recognizable by having the throat and foreneck buff (instead of olive-yellow), the belly buffy white (not pale yellowish), and the upper parts of a considerably darker tinge.

While *H. salmoni* and *H. chrysomelas* are strictly congeneric, I am a little doubtful whether they can be kept in the genus *Hemithraupis*, for the typical species, *H. ruficapilla* Vieill., and its allies have a much shorter, broader, less constricted bill.

H. salmoni is peculiar to the humid forest-districts of Western Colombia and North-western Ecuador.

52. BUARREMON BRUNNEINUCHA Lafr.

Embernagra brunneinucha Lafresnaye, Rev. Zool. ii. p. 97 (1839.—“Mexico”).

Buarremon brunneinuchus Scater & Salvin, P. Z. S. 1879, p. 504 (Concordia, Medellín, Santa Elena).

No. 3743. ♂ ad. Pueblo Rico: 9.ix.08.—Wing 81; tail 83; bill $17\frac{1}{2}$ mm.

* *Tachyphonus chrysomelas* Scater & Salvin, P. Z. S. 1869, p. 440, pl. xxxii. (Cordillera del Chucú, Veragua).

"Iris and feet dark brown, bill black."

Identical with specimens from Bogotá and Venezuela (Cumbre de Valencia, Mérida). Typical Mexican birds are not available. *Cfr.* Ridgway, Bull. U.S. Mus. no. 50, pt. i. p. 466.

53. ARREMON AURANTIROSTRIS OCCIDENTALIS, subsp. n.

No. 2557. ♂ vix ad. Juntas, Río Tamaná (405 ft.), 26.ii.09.—Wing 73; tail 56; bill $15\frac{1}{2}$ mm.

No. 2573. ♂ ad. Condoto, R. Condoto (150 ft.), 27.iii.09.—Wing 73; tail 58; bill $14\frac{1}{2}$ mm.

"Iris dark brown, feet pink, bill bright orange-red."

Messrs. Salvadori and Festa* have most correctly pointed out the differences between specimens from Western and Eastern Ecuador. The large series in the Munich Museum, however, proves that the birds from the western slopes of the Andes are clearly distinct from *A. erythrorhynchus* of Bogotá, and constitute a third, hitherto overlooked race. *A. spectabilis*, *A. erythrorhynchus*, and the new form are evidently the southern representatives of the Central American *A. aurantirostris* Lafr.† and should, according to my view, be ranked as subspecies of the latter. The northern bird may, however, readily be distinguished by its much larger, heavier bill, much broader, black jugular band, and pure olive-green black.

Characters, range and synonymy of the three races are as follows:—

(a) *A. AURANTIROSTRIS SPECTABILIS* ScL.

Arremon spectabilis Sclater, P. Z. S. 1854, p. 114, pl. lxvii. (Apr. 1855.—Quijos, East Ecuador); idem, P. Z. S. 1856, p. 82 (Quixos); idem, P. Z. S. 1858, p. 72 (Rio Napo, E. Ecuador); idem, Cat. B. Brit. Mus. xi. 1886, p. 275 (part.: *e-g*, Rio Napo; *h*, Sarayacu; *p*, Eastern Peru); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 357, 1899, p. 20 (Rio Santiago and R. Zamora, E. Ecuador).

A. erythrorhynchus (nec Sclater) Berlepsch & Taczanowski, P. Z. S. 1883, p. 548 (Huambo, E. Peru; in text of *A. spectabilis* no. 49); Taczanowski, P. Z. S. 1882, p. 16 (Huambo); idem, Orn. Pérou, ii. 1884, p. 535 (Huambo).

Habitat. EASTERN ECUADOR: Quijos (fide *Gould*), Rio Napo (fide *Verreaux*), La Concepcion (*Petit*), Sarayacu (*Buckley*), R. Santiago and R. Zamora (*Festa*); NORTH PERU: Huambo (*Stolzmann*).

Characters. Back, larger upper wing-coverts, and outer webs of remiges deep brownish or rufescent olive; bend of the wing bright orange; bill small and stout. Wing 70–73; tail 58–60; bill $12\frac{1}{2}$ – $13\frac{1}{2}$ mm.

Material. A series from La Concepcion, Rio Napo, East Ecuador, obtained by Louis Petit, in the Munich Museum.

* Boll. Mus. Zool. Torino, xiv. no. 357, 1899, p. 21.

† Rev. Zool. x. p. 72 (1847.—Panama).

Observations. As already stated by Dr. Selater and more recently by Salvadori and Festa, birds from Eastern Ecuador are easily recognizable by the reddish-orange shoulder-spot and the dark brownish-olive colour of the upper parts. From the remarks of Berlepsch and Taczanowski it is evident that the specimens from Huambo, N. Peru, belong to the same race.

(b) *A. AURANTHIROSTRIS ERYTHORHYNCHUS* Sel.

Arremon erythrorhynchus Selater, P. Z. S. 1855, p. 83, pl. lxxxix. (June 1855—"in Nova Grenada, Bogotá"); idem, l. c. p. 154 (Bogotá); idem, l. c. 1858, p. 83 (Bogotá).

A. spectabilis Selater, Cat. B. Brit. Mus. xi. p. 276 (part. *a, b*: Bogotá).

Habitat. EASTERN COLOMBIA: known only from Bogotá collections.

Characters. Back, larger upper wing-coverts, and outer webs of remiges clear yellowish olive-green; bend of the wing light lemon-yellow; bill small and stout (like the preceding form). Wing: ♂ 74, ♀ 70; tail: ♂ 60-64, ♀ 56-58; bill 13 mm.

Material. A series from Bogotá in the Munich Museum.

Observations. Bogotá skins are quite uniform in their characters and always readily distinguishable.

(c) *A. AURANTHIROSTRIS OCCIDENTALIS*, subsp. n.

A. erythrorhynchus (nec Selater) Selater, P. Z. S. 1860, p. 85 (Nanegal, W. Ecuador); idem, l. c. p. 274 (Babahoyo); idem, l. c. p. 293 (Esmeraldas); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 357, 1899, p. 21 (Rio Peripa, Guala, W. Ecuador; crit., synonym.).

A. spectabilis (nec Selater) Taczanowski, P. Z. S. 1877, p. 332 (Palma, distr. of Guayaquil, S.W. Ecuador); Selater & Salvin, P. Z. S. 1879, p. 505 (Remedios, W. Colombia); Berlepsch & Taczanowski, P. Z. S. 1883, p. 548 (Chimbo, S.W. Ecuador); Selater, Cat. B. Brit. Mus. xi. p. 275 (part.: *c, d*, Remedios; *i-n*, Sta. Rita, Nanegal, Babahoyo, W. Ecuador); Hartert, Nov. Zool. v. 1898, p. 483 (Cachabí, Chimbo); Goodfellow, Ibis, 1901, p. 471 (Santo Domingo, S. Nicolas); Ménégau in: Mission Arc Mérid. Equat. ix. 1, p. B 81 (S. Domingo, Pachijal).

Habitat. WESTERN ECUADOR: Palma (*Jelski*), Babahoyo (*Fraser*), Chimbo (*Stolzmann, Rosenberg*), Santa Rita (*Eckley*), Guala, Rio Peripa (*Festa*), Santo Domingo (*Goodfellow, Rivet*), Nanegal (*Fraser*), Esmeraldas, (*Fraser*), Pachijal (*Rivet, Cachabí, Rosenberg*), etc. WESTERN COLOMBIA: Juntas, Condoto, Rio San Juan, Chocó (*Palmer*), Remedios, Antioquia (*Salmon*).

Characters. Colour of back, larger wing-coverts, and outer webs of quills intermediate between *A. a. spectabilis* and *A. a. erythrorhynchus*, neither dark brownish olive nor clear yellowish green, but intense olive-green, somewhat shaded with golden; bend of the wing lemon- or gamboge-yellow, but never orange; bill

considerably larger, longer as well as slenderer, than in both of its allies.—Wing: ♂ 70–75, ♀ 67–70; tail: ♂ 58–63, ♀ 53–58; bill 14–15½ mm.

Type in the Zoological Museum, Munich, no. 09.5862. ♂ ad. Condoto, Rio Condoto, W. Colombia, 150 feet, 27 March, 1909. M. G. Palmer coll. no. 2573.

Material. Two adult males from Western Colombia, eight adults (of both sexes) and young from Western Ecuador (Quito, Paramba, San Javier, Lita, Carondelet, etc.).

Observations. I cannot perceive any difference between Colombian and Ecuadorian specimens. The characters indicated above are perfectly constant in the large series (15) examined by me.

A. a. occidentalis ranges from near sea-level up to about 3500 feet (Paramba, Rio Mira).

54. PSITTOSPIZA RIEFFERII RIEFFERII Boiss.

Tanagra Riefferii Boissonneau, Rev. Zool. iii. p. 4 (1840.—Santa-Fé-de-Bogotá, Colombia).

Psittospiza riefferi Sclater & Salvin, P. Z. S. 1879, p. 505 (Envigado, Concordia, Medellín, Remedios, Santa Elena).

Nos. 2790, 2791. ♂ ♀ ad. Tatamá Mountain, 7600 ft, 9.x.09. Wing 110, 106; tail 81, 79; bill 18 mm.

“Iris brown, feet and bill scarlet.”

Agreeing with specimens from Bogotá and Western Ecuador, but bill slightly larger.

P. r. riefferii is well-known as an inhabitant of the mountains of Colombia and Ecuador. In Peru and Bolivia it is replaced by *P. riefferii elegans* Tsch.*, of which we have a good series from various localities in the Munich Museum.

55. SALTATOR ATRIPENNIS Scl.

Saltator atripennis Sclater, Proc. Acad. N. Sci. Philad. viii. p. 261 (1856.—Popayan, Colombia); Sclater & Salvin, P. Z. S. 1879, p. 505 (Medellin).

No. 2821. ♂ ad. Pueblo Rico, 5200 ft., 29.x.09.—Wing 108; tail 102; bill 19 mm.

“Iris dark brown, feet and bill black.”

This bird, which can be considered as typical, agrees perfectly with Sclater's original description, having the top of the head black etc. Two specimens from the neighbourhood of Quito (Ecuador) in our Museum have a somewhat shorter, stouter bill, and the crown dark cinereous, merely mottled with blackish on the forehead and above the white eyebrow. However, they may be not quite adult.

S. atripennis is known only from the highlands of Colombia and Ecuador.

* *Saltator elegans* Tschudi, Arch. f. Naturg. 10; i. p. 288 (1844.—Peru).

56. *SALTATOR MAXIMUS* P. L. S. Müll.

Tanagra maxima P. L. S. Müller, Natursyst. Suppl. p. 159 (1776—*ex* Daubenton, Pl. Enl. 205: Cayenne).

Saltator magnus Scater & Salvin, P. Z. S. 1879, p. 505 (Remedios, Medellín, Neche); Berlepsch, Journ. f. Orn. 1884, p. 293 (Bucaramanga).

Nos. 2432, 2434. ♂ ♀ ad. Nóvita: 24.xii.08.—Wing 100, 98; tail 89, 91; bill 18, 19 mm.

Nos. 2195, 2021. ♂ ♀ ad. Noanama: 27.viii., 17.x.08.—Wing 98, 95; tail 92, 85; bill 19 mm.

Nos. 2383, 2047. ♀ ♀ imm. Nóvita: 9.xii.09; Noanama: 2.ix.08.

"Iris dark brown, feet dark grey, bill black, mandible blue-grey."

The majority of these skins have the back decidedly purer and lighter green than our large series from Eastern South America (Cayenne, Venezuela, Pará, E. Ecuador, etc.), though one or two are scarcely distinguishable on this score.

57. *PITYLUS GROSSUS* Linn.

Loxia grossa Linnæus, Syst. Nat. xii. 1, p. 307 (1766.—"America": *ex* Brisson; we substitute *Cayenne* as type locality).

Pitylus grossus Cassin, Proc. Acad. Philad. 1860, p. 140 (Falls of the River Truando); Scater & Salvin, P. Z. S. 1879, p. 505 (Remedios, Neche).

Nos. 2114, 2157, 2158. ♂ ♂ ad. Sipi: 26.ix., 5.x.08.—Wing 93-97; tail 82-85; bill 18-19 mm.

No. 2115. ♀. Sipi: 24.ix.08.—Wing 93; tail 83; bill 17½ mm.

"Iris dark brown, feet grey, bill bright scarlet."

Not different from specimens obtained in Venezuela, Brazil, and Eastern Ecuador.

58. *CASICUS UROPYGIALIS* Lafr.

Cassicus uropygialis Lafresnaye, Rev. Zool. vi. p. 290 (1843.—"Colombie," sc. Santa Fé de Bogotá); Scater & Salvin, P. Z. S. 1879, p. 509 (Jerico).

C. uropygialis? Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 139 (Falls of the R. Truando).

Nos. 1995, 2009, 2088. ♂ ♂ ad. Mouth of Calima, 17.viii.; Noanama: 25.viii.; near Sipi: 17.ix.08.—Wing 133-138; tail 96-98; bill 28-30 mm.

Nos. 1996, 2092. ♀ ♀ ad. Mouth of Calima: 17.viii.; Sipi: 19.ix.08.—Wing 122, 123; tail 90; bill 26, 28 mm.

"Iris light (turquoise) blue, feet black, bill light yellow."

The series agrees with Bogotá skins and others from N.W. Ecuador. *C. microrhynchus* Scat. & Salv.*, from Central America,

* *Cassidix microrhynchus* Scater & Salvin, P. Z. S. 1864, p. 353 (Lion Hill, Panama).

is much smaller and has a considerably shorter, slenderer bill, but is most probably only the northern representative of *C. uropygialis*. The specimens obtained by Lieut. Michler's party on the Falls of the Rio Truando, although referred by Mr. Ridgway* to *C. microrhynchus*, are more likely to belong to the present form (*cf.* Cassin, Proc. Ac. N. Sci. Philad. 1867, p. 64).

59. *AMBYLCERCUS HOLOSERICEUS* Licht.

Sturnus holosericeus Lichtenstein, Preis-Verz. Mex. Vög. p. 1 (1831.—Mexico); Journ. f. Ornith. xi. 1863, p. 55 (reprint).

No. 1982. (♀). Guineo, Rio Calima: 8.viii.08.—Wing 92; tail 86; bill $27\frac{1}{2}$ mm.

"Iris white, feet black, bill light yellow."

This specimen agrees with others from Western Ecuador, in size and colour. I have not seen typical Mexican birds, which may be different.

60. *CASSIDIX ORYZIVORA VIOLEA* Bangs.

[*Oriolus oryzivorus* Gmelin, Syst. Nat. 1, i. p. 386 (1788—*ex* Latham: Cayenne)].

Cassidia oryzivora violea Bangs, Proc. New Engl. Zool. Cl. ii. p. 11 (1900.—La Concepcion, Santa Marta, Colombia).

Cassidia oryzivora (errore) Scater & Salvin, P. Z. S. 1879, p. 510 (Concordia, Antioquia, Remedios); Scater, P. Z. S. 1860, p. 140 (Pallatanga, W. Ecuador); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 357, p. 30 (Rio Peripa, R. Daule, W. Ecuador); Hartert, Nov. Zool. v. p. 485 (Paramba, Chimbo, W. Ecuador).

No. 2429. ♂ ad. Nóvita, 150 ft., 23.xii.08.—Wing 200; tail 152; bill 37 mm.

No. 2823. ♂ ad. Pueblo Rico, 5200 ft., 30.x.08.—Wing 210; tail 162; bill $39\frac{1}{2}$ mm.

No. 2413. ♀ ad. Nóvita: 18.xii.08. Wing 153; tail 120; bill 34 mm.

"Iris light yellow, bill and feet black."

C. o. violea is an excellent form, easily recognizable by the strong violet-purple gloss of the plumage. In typical *C. o. oryzivora*, from Cayenne, N. Brazil, Venezuela, etc., the general colour is dull black with bronzy reflection, and very little, if any, violet admixture on pileum and chest. Specimens from Western Ecuador also belong to *C. o. violea*.

61. *XANTHORHYNCHUS MESOMELAS SALVINII* Cass.

[*Psarocolius mesomelas* Wagner, Isis, 1829, p. 755 (1829.—Mexico.)]

Ixerus salvinii Cassin, Proc. Acad. N. Sci. Philad. 1867, p. 51

* Bull. U.S. Mus. no. 50, pt. ii, p. 190.

(1867.—Costa Rica, Nicaragua, New Granada (Atrato River, Bogotá), etc.; type from Costa Rica, *cf.* Stone, *l. c.* vol. li. 1899, p. 34).

I. mesomelas Cassin, Proc. Ac. Philad. 1860, p. 140 (River Atrato); Sclater & Salvin, P. Z. S. 1879, p. 509 (Neche).

No. 2614. ♀ ad. Condoto, R. Condoto: 20.iv.09.—Wing 94; tail 100; bill 20 mm.

No. 1971. ♂ juv. Guineo, R. Calima: 5.viii.08.

"Iris dark brown, feet blue, bill black."

The adult bird agrees with Bogotá skins. The length of the wing, in the latter, varies from 93 to 96 mm. None of my Colombian specimens showing any trace of white edging to the inner secondaries, I consider *X. m. salvinii* as a well-characterized race.

In S.W. Ecuador (district of Guayaquil) and N.W. Peru (Tumbez, Lechugal, Callacate, etc.) another distinct form is met with. It has been named *X. m. taczanowskii* Ridgw.*, and may be recognized by its inferior size (wing 85–88 mm.), lesser extent of black at the base of the outer rectrices, and by having conspicuous yellowish-white edges to the innermost secondaries. *Cfr.* Berl. & Tacz. P. Z. S. 1883, p. 552 (s. n. *I. mesomelas*).

62. HYPOPYRRHUS PYROHYPOGASTER Tarragon.

Cassicus pyrohypogaster Tarragon, Rev. Zool. x. p. 252 (1847.—"Nouvelle Grenade").

Hypopyrrhus pyrrhogaster Sclater & Salvin, P. Z. S. 1879, p. 510 (Envigado, Santa Elena).

Nos. 2832, 2833. ♀ ♀ (in moult). Pueblo Rico, 5200 ft., 4.xi.09.

No. 3768. ♂ ad. Siató, 5200 ft., 23.ix.09.—Wing 142; tail 140; bill 31 mm.

Nos. 3758, 3761, 3762, 3770. ♀ ♀. Siató: 17, 18, 23.ix.09.—Wing 127–130; tail 128–133; bill 27–29 mm.

"Iris light yellow, feet and bill black."

The specimens agree with a number of Bogotá skins in the Munich Museum. As will be seen from the above measurements the females have much shorter wings and tail.

H. pyrohypogaster is restricted to the highlands of Colombia. It is not uncommonly met with in Bogotá collections, and Salmon procured several examples in Antioquia.

63. CYANOCORAX AFFINIS AFFINIS Pelz.

Cyanocorax affinis Pelzeln, Sitzungsber. Ak. Wiss. Wien, math.-naturw. Cl. xx. 1, p. 164 (1856.—Bogotá); Sclater & Salvin, P. Z. S. 1879, p. 510 (Cauca, Remedios).

* *Icterus mesomelas taczanowskii* Ridgway, Proc. Wash. Acad. Sci. iii. p. 153 (1901.—Guayaquil, S.W. Ecuador).

C. pileatus (nec Temminck) Cassin, Proc. Acad. N. Sc. Philad. 1860, p. 138 (Rs. Truando and Nercua, N.W. Colombia *).

Nos. 2053, 2459. ♂ ♀ ad. Noanama: 3.ix.08, 11.i.09.—Wing 170, 165; tail 175, 168; bill 27, 29 mm.

No. 2537. ♂ ad. El Tigre, R. Tamaná, 13.ii.09.—Wing 165; tail 166; bill 29 mm.

No. 3746. ♂ imm. Pueblo Rico, 5200 ft., 10.ix.09.—Wing 170; tail 160; bill 29 mm.

“Iris lemon-yellow, feet and bill black.”

In the pale yellowish-white colour of the under parts and tail-end these birds agree with Bogotá skins, but are slightly smaller †. In size they approach *C. a. zeledoni*, from Chiriqui and Costa Rica; the latter form may, however, easily be distinguished by the bright creamy-yellow belly, etc.

A good series from Cartagena (the type locality of *C. sclateri* Heine ‡) is required to show whether the slight difference in size between birds from Bogotá and Western Colombia is constant.

C. a. affinis is confined to Colombia, ranging from near sea-level up to about 5000 feet altitude.

64. CYANOLYCA PULCHRA LAWY.

Cyanocitta pulchra Lawrence, Ann. Lyc. N. H. N. Y. xi. 1875, p. 163 (Feb. 1876.—Quito, Ecuador).

No. 2789. ♂ ad. Tatamá Mountain, 7600 ft., 9.x.08.—Wing 130; tail (moulting) about 135; bill 30 mm.

“Iris, feet, and bill black.”

So far as I am aware this is the second known specimen of this fine species, which was described by Mr. Lawrence from a single Quito skin in his collection. The bird corresponds exactly to the original description with the sole exception that the smoky-blackish chest shows a faint cobalt-bluish tinge. *C. pulchra* cannot be confused with any other species. It differs from all the forms of the *C. armillata* group by the beautiful silvery bluish-white colour of the crown and nape, terminated behind by a distinct cross-band of bright ultramarine blue; by the dull brownish-black upper back, without any blue tinge; by the much duller cobalt-blue throat-patch; by lacking the black jugular crescent, so conspicuous a feature in all of its allies; by the smoky-blackish chest, and much duller bluish belly, etc. Moreover, the bill is much stouter and larger, while the tail, on the other hand, is much shorter.

There can be no doubt that *C. pulchra* is an excellent species, not much like any other member of the genus.

* Ridgway (Bull. U. S. Mus. no. 50, pt. iii. p. 305), with a query, refers the above quotation to the Central American race *C. a. zeledoni* Ridgw. (Auk, xvi. 1899, p. 255.—Talamanca, Costa Rica). But as specimens from Cartagena, N. Colombia, agree with *C. a. affinis* from Bogotá etc., those from Truando and Nercua most certainly belong also to the latter, inasmuch as the fauna of those districts is essentially the same as that of the San Juan River.

† Bogotá skins measure: wing 175–180; tail 175–180 mm.

‡ Journ. f. Ornith. viii. p. 114 (1860.—“Cartagena (an in Guatemala).”)

65. SAYORNIS CINERACEA CINERACEA Lafr.

Tyrannula cineracea Lafresnaye, Rev. Zool. xi. p. 7 (1848.—“Caracas, in Venezuela”).

Sayornis cineracea Sclater & Salvin, P. Z. S. 1879, p. 511 (Medellin, Frontino).

S. ardosiacus (nec *Tyrannula ardosiacus* Lafresnaye, 1844) Cassin, Proc. Acad. N. Sc. Philad. 1860, p. 144 (Falls of the Rio Truando); *cfr.* Ridgway, Bull. U. S. Mus. no. 50, pt. iv. pp. 512, (footnote c), 594 (note a).

No. 2831. ♀ imm. Pueblo Rico, 5200 ft., 4.xi.09.—Wing 81; tail 73; bill $14\frac{1}{2}$ mm.

“Iris dark brown, feet and bill black.”

Identical with examples from Merida and Bogotá.

66. COPURUS LEUCONOTUS Lafr.

Copurus leuconotus Lafresnaye, Rev. Zool. v. p. 335 (1842—“in Bolivia,” errore; we substitute Bogotá, Colombia*); Sclater & Salvin, P. Z. S. 1879, p. 511 (Remedios).

Nos. 1983, 2054, 2068, 2280, 2346. ♂ ♂ ad. Guineo; 10.viii.08; Noanama: 3, 5.ix.08; Nóvita: 13, 28.xi.08.—Wing 72–75; tail 170–183; bill 8–9 mm.

Nos. 1984, 2345, 2347. ♀ ♀. Guineo: 10.viii.08.; Nóvita; 27, 28.xi.08.—Wing 70; tail 125–135; bill 8 mm.

“Iris dark brown, feet and bill black.”

The females are smaller, with the median rectrices less elongated, and the pileum is uniform dark sooty without hoary margins.

There is apparently no difference between specimens from so widely separated localities as Costa Rica and Colombia, nor do skins from Western Ecuador differ.

67. PLATYTRICCHUS MYSTACEUS ALBOGULARIS ScL.

[*Platyrrhynchus mystaceus* Vieillot, Nouv. Dict. xxvii. p. 14 (1818—ex Azara: Paraguay).]

Platyrrhynchus albogularis Sclater, P. Z. S. 1860, p. 68 (1860.—Pallatanga, W. Ecuador).

P. canceroma (nec Temminck) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 144 (Truando).

No. 2811. ♂ ad. Pueblo Rico: 25.x.09.—Wing 62; tail 36; bill 12 mm.

“Iris dark brown, feet pink, bill black.”

This bird is quite typical. Skins from Chiriqui and Costa Rica agree in coloration, but are slightly smaller (wing 57–59 mm.). I have not seen specimens from Eastern Ecuador† and Northern Peru‡ which may, or may not, be strictly referable

* “Bolivia” is an obvious pen-slip for “Colombia,” the paper having as title “Oiseaux nouveaux de Colombie.”

† Tacz. & Berl. P. Z. S. 1885, p. 88 (Machay).

‡ Taczanowski, P. Z. S. 1879, p. 233 (Tambillo).

to *P. m. albogularis*. Birds from Northern Venezuela (San Esteban, Tocuyo, etc.), however, are very different, being much paler and more greenish brown above, having the throat tinged with pale yellowish, the lower mandible whitish instead of mainly blackish, etc., etc. They agree perfectly with topotypes of *P. insularis* Allen* from Tobago, and other examples from Trinidad and Bermudez (Cumaná), while a series secured by the late H. Whitely on Mount Roraima, Guiana, is intermediate between *P. m. mystaceus* (of S.E. Brazil and Paraguay) and *P. m. insularis*. Cf. Hellmayr, Nov. Zool. xiii. 1906, p. 22.

According to my views, the range of the various races of the group is as follows:—

- (a) *P. mystaceus mystaceus* Vieill. South-eastern Brazil from Bahia and Minas southwards to Rio Grande do Sul, Paraguay, and the adjoining province Misiones, Argentine.
- (b) *P. mystaceus insularis* Allen. Tobago, Trinidad, and North coast of Venezuela†, from Cumaná (Bermudez) west to Tocuyo. [Specimens from Mt. Roraima, British Guiana, and from the Orinoco R. (Caicara), may form yet another race.]
- (c) *P. mystaceus albogularis* Scl. Western Ecuador and Colombia, Panama, Chiriqui, and parts of Costa Rica. [East Ecuador and North Peru?]

68. RHYNCHOCYCLUS CINEREICEPS FLAVOTECTUS Hart.

[*Cyclorhynchus cinereiceps* Sclater, Ibis, i. p. 443 (1859.—Oaxaca, Mexico).]

Rhynchocyclus megacephala flavotectus Hartert, Nov. Zool. ix. p. 608 (1902.—San Javier, N.W. Ecuador).

Nos. 2250, 2396. ♂♂ ad. Nóvita: 8.xi., 12.xii.08.—Wing 63; tail 50½, 51; bill 12, 13 mm.

No. 2046. ♂ imm. Noanama: 2.ix.08.—Wing 62; tail 51; bill 12 mm.

“Iris brown, feet dark grey, maxilla black, mandible horn-coloured.”

The specimens agree in every respect with the types from San Javier and two other examples from Paramba, N.W. Ecuador, kindly lent by the authorities of the Tring Museum. The species is for the first time recorded from Colombia. *R. c. flavotectus*, although described as a subspecies of *R. megacephala* auct. nec Swains.‡, is much more nearly allied to *R. cinereiceps*, of Central America, in fact its southern representative. In the coloration of the under parts the two birds are perfectly alike; but *R. c. flavotectus* may be recognized by its much duller and darkee

* *Platyrhynchus insularis* Allen, Bull. Amer. Mus. N. Y. ii. p. 143 (1889.—Tobago).

† *P. albogularis* Sclater, Cat. B. xiv. p. 67 (part., specimens *d*, *e*: S. Esteban, Venezuela).

‡ Cf. Hellmayr, Verhandl. zool.-bot. Ges. Wien, liii. 1903, pp. 206-8.

green (instead of yellowish-green) back, much brighter yellow edges to the remiges, and by having the median and greater wing-coverts broadly edged with bright yellow. As a rule, the cinereous colour of the pileum is somewhat darker, and the tail on the average shorter.

Specimens from N.W. Ecuador measure as follows:—

(♂) ad. S. Javier: wing 66; tail 53; bill 12 mm.

(♀) ad. S. Javier (type): wing 62; tail 51; bill 12 mm.

Two adults ("♂, ♀"), Paramba: wing 62, 63; tail 50, 51½; bill 12½, 13 mm.

I at first thought that *R. sulphurescens asemus* Bangs * might be the same as the present species. However, Mr. Bangs gives much larger dimensions (wing 70, tail 59 mm.) and compares his new form with *R. sulphurescens*, to which *R. c. flavotectus* is but very distantly related.

R. c. flavotectus is another characteristic form of the forest district of the Pacific Coast, ranging from sea-level up to about 3500 feet (Paramba).

69. CRASPEDOPRION ÆQUINOCTIALIS Sel.

Cyclorhynchus æquinoctialis Sclater, P. Z. S. 1858, p. 70 (1858.—Rio Napo, E. Ecuador).

C. brevirostris (nec Cabanis) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 144 (Rio Truando).

Rhynchochylus æquinoctialis Hartert, Nov. Zool. v. 1898, p. 487 (Cachabi, N.W. Ecuador).

No. 2422. ♂ ad. Nóvita: 21.xii.08.—Wing 78; tail 65; bill 16 mm.

No. 2485. ♂ ad. Noanama: 16.i.09.—Wing 80; tail 69; bill 15 mm.

"Iris dark brown, feet dark blue, maxilla black, mandible horny-white."

These skins are practically identical with an adult male from N.W. Ecuador. All have the greater upper wing-coverts and the inner secondaries conspicuously edged with ochreous-buff, exactly like *C. olivaceus* Temm.,† from Eastern Brazil; they differ, however, from the last named-species in their larger size, much larger bill, deeper green throat and chest, etc.

I am not sure whether they are really referable to *C. æquinoctialis*, not having examined specimens from Eastern Ecuador (the type locality). According to Sclater's original description and later remarks‡, the true *C. æquinoctialis* appears to lack the fulvous margins to the wing-coverts and inner secondaries.

C. æquinoctialis, as understood here, ranges from Ecuador north to the Isthmus of Panama.

* Proc. Biol. Soc. Wash. xxiii. p. 73 (1910.—Pavas, Western Colombia, 4400 ft.).

† *Platyrrhynchos olivaceus* Temminck, Rec. Pl. Col., livr. ii. pl. 12. fig. 1 (1820.—"Brésil").

‡ Cat. B. Brit. Mus. xiv. p. 166.

70. *TODIROSTRUM CINEREUM CINEREUM* Linn.

Todus cinereus Linnaeus, Syst. Nat. xii. 1, p. 178 (1766—*ex* Edwards, Glean. N. H. ii. p. 110, pl. 262. fig. inf.: Surinam).

Todirostrum cinereum Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 144 (Carthagenae); Sclater & Salvin, P. Z. S. 1879, p. 512 (Medellin, Santa Elena, Remedios).

No. 1973. ♂ ad. Guineo, Rio Calima: 6.viii.08.—Wing 44; tail 35; bill 14 mm.

"Iris white, feet blue-grey, bill black."

Perfectly identical with specimens from Bogotá, Venezuela (San Esteban), Cayenne, etc. Chin and throat are yellow like the remaining under parts.

In Western Ecuador this form is represented by *Todirostrum cinereum sclateri* Cab. & Heine*, at once known by having the chin and upper throat white. It extends southwards into the district of Tumbes, N.W. Peru.

71. *CNIPODECTES SUBBRUNNEUS SUBBRUNNEUS* ScL.

Cyclorhynchus subbrunneus Sclater, P. Z. S. 1860, p. 282 (1860.—Babahoyo, S.W. Ecuador).

Cnipodectes subbrunneus Sclater & Salvin, P. Z. S. 1879, p. 514 (Remedios, Antioquia).

No. 2509. ♂ ad. Nóvita: 30.i.09.—Wing 94; tail 87; bill 17 mm.

No. 2539. ♂ ad. El Tigre: 13.ii.09.—Wing 95; tail 92; bill 17 mm.

Nos. 2605, 2606. ♂ ♂ ad. Condoto: 16, 16.iv.09.—Wing 95, 92; tail 89, 86; bill $16\frac{1}{2}$, 17 mm.

No. 2591. ♂ ad. Condoto: 10.iv.09.—Wing 87; tail 83; bill $16\frac{1}{2}$ mm.

No. 2569. ♂ imm. Nóvita: 15.iii.09.—Wing 75; tail 69; bill $16\frac{1}{2}$ mm.

"Iris pink (in adults), brown (in imm. male, no. 2569), feet grey, maxilla black, mandible pink (adults), horn-coloured (young)."

This series is most interesting, proving as it does that the so-called "*minor*" from Panama and Western Ecuador are nothing but the young of the larger *subbrunneus*. This had already been suspected by me when, some years ago, I carefully studied and measured the entire material in the British Museum, but in the absence of a good series from any locality, it was then impossible to arrive at a definite conclusion. The occurrence side by side of these two "species" differing only in size always appeared to me a phenomenon hardly reconcilable with modern views of zoogeographical distribution.

No. 2569, a young bird, as manifested by the fluffy texture of the plumage, differs from the other specimens in its much shorter

* *Triccus Sclateri* Cabanis & Heine, Mus. Hein. ii. p. 50 (1859.—Peru).

wings and tail, less developed crest, more rufescent brown colour of the upper parts, and especially in having distinct, ochraceous-buff apical edges to the greater wing-coverts. An unsexed bird obtained at Santa Rita, W. Ecuador, by Buckley's collector Villagomez, and two skins, one marked "♂," from Panama, "McLeannan leg.," in the British Museum, are also immature. They were erroneously referred by Dr. Sclater to the Peruvian race *C. s. minor*, the type of which is likewise a young bird!

However, adult males from Chamicuros (the type locality of *C. minor*) differ slightly from those of Western Ecuador and Colombia (Remedios) in having both upper and under surfaces rather paler brown. An adult male obtained on the Rio Purús, W. Brazil, shows the same variation when compared with our Chocó series. Hence the name *C. s. minor* may well be retained for the Amazonian race, though its (rather trifling) characters should be confirmed by a better series of fresh skins.

According to my views there are two very closely allied races:—

- (1) *C. s. subbrunneus* Scl., ranging from S.W. Ecuador through Western Colombia to Panama.
- (2) *C. s. minor* Scl., ranging from Eastern Peru (Chamicuros) to W. Brazil (Rio Purús).

Their synonymy and ranges are as follows:—

(a) *C. SUBBRUNNEUS SUBBRUNNEUS* Scl.

Cyclorhynchus subbrunneus Sclater, P. Z. S. 1860, p. 282 (1860.—Babahoyo, S.W. Ecuador); idem, l. c. p. 295 (Esmeraldas, N.W. Ecuador); Lawrence, Ann. Lyc. N. H. N. Y. vii. 1862, p. 473 (Panama).

Myiochanes subbrunneus Sclater, Cat. Amer. B. 1862, p. 232 (Babahoyo, Esmeraldas).

Myiochanes sp., Sclater & Salvin, P. Z. S. 1864, p. 360 (Panama).

Cnipodectes subbrunneus Sclater & Salvin, P. Z. S. 1879, p. 514 (Remedios, Antioquia); Sclater, Cat. Birds Brit. Mus. xiv. p. 197, pl. xvi. (part.: Babahoyo, Esmeraldas, Balzar: Ecuador; Remedios, Colombia); Salvin & Godman, Biol. Centr.-Amer., Aves, ii. 1889, p. 55 (part.: Colombia, Panama, Ecuador); Salvadori & Festa, Boll. Mus. Torino, xiv. no. 362, 1899, p. 10 (Rio Peripa, W. Ecuador); Ridgway, Bull. U. S. Mus. no. 50, pt. iv. 1907, p. 484 (Panama, Colombia, W. Ecuador).

C. minor (nec Sclater) Sclater, Cat. B. Brit. Mus. xiv. p. 197 (part.: d, Santa Rita, W. Ecuador; e, f. Panama); Ridgway, Bull. U. S. Mus. no. 50, pt. iv. p. 485 (part.: Panama, W. Ecuador).

Type locality. Babahoyo, S.W. Ecuador.

Range. Western Ecuador: Babahoyo, Esmeraldas (*Fraser*), Rio Peripa (*Festa*), Balzar (*Illingworth*), Santa Rita (*Villagomez*). Western Colombia: Nóvita, El Tigre, Condoto, Chocó distr. (*Palmer*); Remedios, Antioquia (*Salmon*). Panama: Lion Hill (*MacLeannan*), Cascajal Coclé (*Heyde*).

Material.

	Wing.	Tail.	Bill.
Brit. Mus.—One adult from Babahoyo (type)	86;	82;	17 mm.
" " One adult from Esmeraldas, Ecuador ...	92;	82;	16½ "
" " One adult from Balzar, Ecuador	85;	86;	16 "
Munich Mus.—Five ♂ ad. from Chocó, W. Colombia.	87-95;	83-92;	16½-17 "
Brit. Mus.—One ♂ ad. from Remedios, W. Colombia.	88;	83;	17 "
" " One juv. from Sta. Rita, Ecuador	74;	72;	16 "
" " Two juv. from Panama	71, 73;	65, 68;	15, 16 "
Munich Mus.—One ♂ juv. from Chocó, W. Colombia.	75;	69;	16½ "

Adults from W. Ecuador and Colombia are practically identical. From Panama I have seen only young birds.

(b) *C. SUBBRUNNEUS MINOR* Sl.

Cnipodectes minor Selater, P. Z. S. 1883, p. 654 (1884.—Chamicuros, E. Peru); Taczanowski, Orn. Pérou, ii. 1884, p. 294 (Chamicuros); Selater, Cat. B. Brit. Mus. xiv. p. 197 (part.: *a-c*, Chamicuros); Ridgway, Bull. U. S. Mus. no. 50, pt. iv. 1907, p. 485 (part.: Eastern Peru).

Cnipodectes subbrunneus minor Sneathlage, Journ. f. Orn. 1908, p. 12 (Rio Purús, Brazil).

C. subbrunneus (nec Selater) Selater & Salvin, P. Z. S. 1873, p. 281 (Chamicuros); Salvin & Godman, Biol. Centr.-Amer., Aves, ii. 1889, p. 55 (part.: Peru); Berlepsch & Leverkühn, Orn. vi, 1890, p. 16 (Chamicuros).

Type locality. Chamicuros, Eastern Peru.

Range. Eastern Peru: Chamicuros (*Bartlett*). W. Brazil: upper R. Purús (*Huber*).

Material.

	Wing.	Tail.	Bill.
Mus. Brit.—Two adult males from Chamicuros	92;	84, 83;	15½ mm.
" " One ♂ juv. from Chamisuros (type)	72;	64;	15½ "
Mus. Pará.—One adult male from Rio Purús	86;	77	16 "

72. *SERPAPHAGA CINEREA CANA* Bangs.

[*Euscarthmus cinereus* Strickland, Ann. Mag. Nat. Hist. xiii. p. 414 (1844.—"Chili").]

Serpophaga cinerea cana Bangs, Proc. Biol. Soc. Wash. xvii. p. 113 (1904.—Chirua, Sierra de Santa Marta, Colombia).

S. cinerea (nec Strickland) Selater & Salvin, P. Z. S. 1879, p. 512 (Envigado, Frontino).

No. 2741. ♂ ad. Pueblo Rico, 5200 ft., Sept. 1909.—Wing 56½; tail 47; bill 9 mm.

" Iris dark brown, feet and bill black."

Identical with specimens from Bogotá and Mérida (Venezuela). Birds from Southern Peru (Andes of Carabaya) which I take to be true *cinerea* are darker grey above, and have the breast more strongly shaded with cinereous, while those from Costa Rica and Chiriqui, *S. cinerea grisea* Lawr. *, are smaller, with the crown more deeply black.

* *Serpophaga grisea* Lawrence, Ann. Lyc. N. H. N. Y. x. p. 139 (1871.—San José, Costa Rica).

73. *MIONECTES OLIVACEUS HEDERACEUS* Bangs.

[*Mionectes olivaceus* Lawrence, Ann. Lyc. N. H. N. Y. ix. p. 111 (1868.—Barranca and Dota, Costa Rica).]

Mionectes oleagineus hederaceus Bangs, Proc. Biol. Soc. Wash. xxiii. p. 73 (1910.—Pavas, Western Cordillera, Colombia, 4400 ft.).

M. striaticollis (errore) Sclater, P. Z. S. 1859, p. 144 (Pallatanga, W. Ecuador); idem, P. Z. S. 1860, p. 93 (Nanegal, W. Ecuador); Berlepsch & Taczanowski, P. Z. S. 1884, p. 296 (Surupata, Chaguarpata, W. Ecuador; *fide* H. v. Berlepsch in litt.).

M. olivaceus (errore) Hartert, Nov. Zool. v. 1898, p. 487 (Chimbo); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 6 (Niebli, Rio Peripa, W. Ecuador); Goodfellow, Ibis, 1901, p. 704 (San Nicolas, Guala, Canzacota, W. Ecuador); Hartert, Nov. Zool. ix. 1902, p. 607 (Lita, Paramba, N.W. Ecuador).

Nos. 1960, 1998. ♂♂. San Joaquim, Bahia del Chocó, l.viii.08; Boca de Colima, R. San Juan, 18.viii.08.—Wing 68, 69; tail 54; bill $12\frac{1}{2}$, 13 mm.

Nos. 2256, 2263, 2322. ♂♂ ad. Nóvita: 10,11,21.xi.08.—Wing 67–69; tail 58; bill 12–13 mm.

No. 2252. ♀ ad. Nóvita: 9.xi.08.—Wing 62; tail 48; bill 12 mm.

“Iris brown, feet light grey, maxilla black, base of mandible pale brown.”

Palmer's series as well as several examples from Western Ecuador differ at a glance from true *M. o. olivaceus*, of Costa Rica and Chiriqui, in having the back much duller, less yellowish green, the pileum more greyish green, and the olive streaks on the anterior under parts much darker and more strongly marked. The Colombian and Venezuelan races, *M. o. galbinus* Bangs* and *M. o. venezuelensis* Ridgw.†, are much brighter green above, the pileum being scarcely darker than the back, and the general colour of the lower surface is much deeper yellow, with the dark streaks more decidedly green.

M. o. hederaceus replaces the typical form in the lowlands and on the Pacific slopes of the Western Cordillera of Colombia and Ecuador.

Whether its ally *M. striaticollis* D'Orb. & Lafr. also occurs in Western Colombia ‡ I am unable to ascertain, but it should be mentioned that the numerous skins I have examined from Western Ecuador were all referable to *M. o. hederaceus*.

* *Mionectes olivaceus galbinus* Bangs, Proc. New Eng. Zool. Cl. iii. p. 85 (1902.—La Concepcion, Santa Marta, N. Colombia).

† *M. olivaceus venezuelensis* Ridgway, Proc. Biol. Soc. Wash. xix. p. 116 (1906.—Guacharo, State of Cumana, N. Venezuela).

‡ *M. striaticollis* Sclater & Salvin, P. Z. S. 1879, p. 512 (Santa Elena).

M. s. poliocephalus Bangs, Proc. Biol. Soc. Wash. xxiii. 1910, p. 74 (San Antonio, Rio Cali).

74. *LEPTOPOGON SUPERCILIARIS POLIOCEPHALUS* Cab. & Heine.

[*Leptopogon superciliaris* Tschudi, Arch. f. Naturg. 10, i. p. 275 (1844.—Peru, *i. e.* “Vorwälder” of Central Peru; *cfr.* Tschudi, Faun. Peru., Aves, p. 162.]

L. poliocephalus Cabanis & Heine, Mus. Hein. ii. p. 55 (1859.—“New Granada,” sc. Bogotá).

L. superciliaris (nec Tschudi) Hartert, Nov. Zool. ix. 1902, p. 607 (Lita, Paramba, N.W. Ecuador).

No. 2376. ♂ ad. Nóvita, 150 ft., 7.xii.08.—Wing 69; tail 62; bill 15 mm.

“Iris dark brown, feet and bill black.”

A second specimen from this region I have seen in Count Berlepsch’s collection. It is an adult female, and was obtained by the late Gustav Hopke at San Pablo, 4500 ft. alt., January 21, 1897. (Wing 65; tail $58\frac{1}{2}$; bill $14\frac{1}{2}$ mm.)

The West Colombian birds agree with a series from Bogotá and San Esteban, Venezuela, in size and coloration. Specimens from N.W. Ecuador (Paramba) are also similar.

All these examples differ obviously, however, from *L. s. superciliaris*, of which I have examined a large series from Central and Southern Peru and Northern Bolivia, in the much deeper yellow abdomen, and in having the throat and chest strongly tinged with olive-green. The typical race has the under parts very much paler, about primrose-yellow, with but a slight greenish wash on breast and sides.

The colour of the apical spots to the wing-coverts is of no diagnostic value, for it varies from primrose-yellow to dull ochreous in individuals taken at the same place.

While there can be no question as to the distinctness of *L. s. superciliaris* and *L. s. poliocephalus*, the status of the third geographical race, *L. s. transandinus* Berl. & Tacz.*, from South-western Ecuador, is not yet definitely settled. Two females in Count Berlepsch’s collection are, indeed, much smaller than *L. s. poliocephalus*; but the dimensions given *l. c.* for a male are scarcely inferior to the average measurements of adult males from Colombia and Venezuela. So far as coloration is concerned the two forms are practically identical.

Another uncertainty exists with regard to the Central American birds, which Ridgway and other American naturalists have referred to *L. s. superciliaris* of Peru. This, however, can hardly be correct. Either they belong to *L. s. poliocephalus*, or they may represent yet another race.

75. *ELENEA CINEREA PARAMBÆ* Hellm.

[*Elainea cinerea* Pelzeln, Zur Orn. Bras. ii. pp. 108, 180 (Sept. 1860.—Marabitanas).]

* P. Z. S. 1883, p. 553 (1884.—Chimbo, S.W. Ecuador).

Serpophaga parambae Hellmayr. Bull. B. O. C. xiv. p. 54 (1904.—Paramba, N.W. Ecuador).

[Tring Museum. ♂ ad. Paramba, N.W. Ecuador, 3500 ft. 23.vii. 1899. Miketta coll. no. 473, *Type of species*.—Wing $56\frac{1}{2}$; tail 48; bill 10 mm.]

No. 2494. ♂ imm. N6vita: 26.i.08.—Wing $53\frac{1}{2}$; tail 44; bill $9\frac{1}{2}$ mm.

No. 2196. ♂ juv. Noanama: 17.x.08.—Wing 56; tail 49; bill 10 mm.

“ Iris dark brown, feet and bill black, base of mandible brown.”

On receipt of these specimens it at once occurred to me that they might represent some phase of *S. parambae*, originally described from an adult male in the Tring Museum; and the careful examination of the typical example not only confirmed the correctness of my surmise, but, furthermore, clearly showed that *S. parambae* is merely a western, smaller subspecies of *Elenia cinerea*.

In fact, on comparing the types of the two “species” I find them identical in structural characters as well as in coloration. However, *E. c. parambae* may be recognized by its much shorter wings and tail, and by its rather slenderer, shorter bill.

The immature males obtained by Mr. Palmer differ from the type in the following points:—The back is bright olive-green instead of bluish grey; the tips to the upper wing-coverts and edges to the secondaries are pale yellow, instead of white, the edges to the rectrices olive-green, not cinereous. Moreover, the throat only is white, while the remaining under parts, including axillaries and under wing-coverts, are pale yellow, with obsolete, greyish-white flammulations on the chest. The vertical patch, in no. 2494, is white with a hardly perceptible yellowish hue in its posterior portion, the rest of the pileum ashy grey, as in the adult male, but slightly darker.

The immature birds are not unlike the corresponding stage of *E. c. cinerea**, but can easily be distinguished by having the pileum ashy-grey (not olive-green like the back), the coronal patch white (instead of pale yellow), and the under parts much paler yellow, with the throat conspicuously white. The bill is also narrower and shorter.

E. c. parambae evidently replaces *E. c. cinerea* on the western sides of the Andes in Ecuador and Colombia.

For comparison, the dimensions of seven skins of *E. c. cinerea* are herewith given:—

Five adult males † ... Wing 60–63; tail 55–57; bill 11–12 mm.
Two immature birds ‡ ,, 57–60; ,, 49–53; ,, 11 mm.

* Described by me in Nov. Zool. xv. 1908, p. 46.

† (a) Marabitanas, Rio Negro: type of species; (b) Bogotá, Mus. H. v. B.; (c) Sarayacu, Eastern Ecuador, type of *S. albogrisea* Scl. & Salv.; (d) Chamicuros, E. Bartlett coll.; (e) Suapure, Caura, Tring Museum.

‡ (a) ♀ jr. Suapure, Caura, Tring Museum; (b) Bogotá, Mus. Berlepsch.

76. *LEGATUS ALBICOLLIS ALBICOLLIS* Vieill.

Tyrannus albicollis Vieillot, Nouv. Dict. xxxv. p. 89 (1819—*ex* Azara: Paraguay).

Nos. 2648, 2658. ♂ ♂ ad. Tadó, 230 ft.: 17, 21.v.09.—Wing 82, 81; tail 58, 59; bill 11, 12 mm.

Nos. 2654 (not numbered). ♀ ♀ juv. Tadó: 18, 19.v.09.—Wing 78; tail 58, 59; bill 11 mm.

"Iris brown, feet and bill black."

Not different from Brazilian specimens.

77. *MYIOZETETES CAYANENSIS CAYANENSIS* Linn.

Muscicapa cayanensis Linnæus, Syst. Nat. xii. 1, p. 327 (1766—*ex* Brisson: Cayenne).

Elania cayanensis Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 144 (Turbo).

Myiozetetes texensis (errore) Sclater & Salvin, P. Z. S. 1879, p. 513 (Envigado, Medellín).

No. 2384. ♀ ad. Nóvita: 9.xii.08.—Wing 83; tail (incomplete); bill 13½ mm.

No. 1992. ♂ jr. Boca de Calima: 4.viii.08.—Wing 85; tail 73; bill 14 mm.

"Iris dark brown, feet and bill black."

The adult bird agrees with other specimens from Bogotá, Cayenne, and Pará. About the geographical races of this species *cf.* Hellmayr, Abhandl. Bay. Akad. Wiss. München, ii. Cl. xxii. 3, 1906, pp. 649–650.

M. c. rufipennis Lawr. *, synonymised with the typical form by Mr. Ridgway †, is easily recognizable by the greater extent of rufous on the wings. It inhabits the northern littoral of Venezuela (Valencia, Puerto Cabello, etc.) and is not to be confounded with *M. c. erythroptera* Lafr. ‡ from South-eastern Brazil (Rio, Southern Minas Geraës), which is much larger and has still more rufous on the wings.

78. *CORYPHOTRICCUS ALBOVITTATUS* Lawr.

Pitangus albovittatus Lawrence, Ibis, iv. p. 11 (1862.—Isthmus of Panama).

Coryphotriccus albovittatus Ridgway, Bull. U.S. Mus. no. 50, pt. iv. 1907, p. 669 (Panama).

No. 2421. ♂ ad. Nóvita, Rio Tamaná: 21.xii.08.—Wing 81; tail 69; bill 17 mm.

"Iris brown, feet and bill black."

C. albovittatus, one of the rarest of Neotropical Tyrants, is apparently recorded for the first time from South America, it

* *Myiozetetes rufipennis* Lawrence, Ann. Lyc. N. H. N. Y. ix. p. 267 (1869.—Valencia, Venezuela).

† Bull. U.S. Mus. no 50, pt. iv. p. 446.

‡ *Tyrannula erythroptera* Lafresnaye, Rev. Mag. Zool. (2) v. p. 56 (1853.—Brazil).

having previously been known only as an inhabitant of Eastern Panama.*

The bird agrees very well with Ridgway's description except for its slightly larger size† and the colour of the pileum, which I should call sooty-blackish rather than sooty-brown. From *C. parvus* Pelz.‡ it differs in its duller, less greenish back and white throat (instead of yellow like the remaining under parts). In structural characters the two species are perfectly alike.

So far as I know, the above is the only specimen existing in any European Museum.

79. MYIOBIUS SULPHUREIPYGUS VILLOSUM ScL.

[*Tyrannula sulphureipygia* Sclater, P. Z. S. 1856, p. 296 (Jan. 1857.—Cordova, Mexico).]

Myiobius villosus Sclater, P. Z. S. 1860, p. 93 (1860.—Nanegal, W. Ecuador); Sclater & Salvin, P. Z. S. 1879, p. 514 (Frontino).

M. sulphureipygius (errore) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 144 (Rio Truando).

No. 2427. ♂ ad. Nôvita: 22.xii.08.—Wing 63; tail 54; bill 11 mm.

"Iris dark brown, feet grey, maxilla black, mandible pink."

This bird, like others from Western Ecuador, differs from *M. s. aureatus* Bangs§, of Chiriqui and Costa Rica (Pozo Azul), in its darker, more brownish-green back, deeper ochraceous chest and sides, and more brownish under tail-coverts. The differences between the two races, though slight, appear to be quite constant. Mr. Ridgway|| makes *M. sulphureipygius* a subspecies of *M. xanthopygus* [= *mastacalis* Wied¶], but this is certainly wrong.

M. b. mastacalis is merely the southern form of *M. barbatus*, the two being completely connected by intermediates in North-eastern and Northern Brazil (Piauhy, Maranhão, Pará, Rio Madeira). The representative of the *barbatus* group in Western Ecuador, Colombia, Panama, and Costa Rica is *M. b. atricaudus* Lawr., which is clearly specifically distinct from *M. s. villosus*, with which it occurs in many localities. Mr. Rosenberg's correspondents sent numbers of both forms from the same places in N.W. Ecuador.

* Whether the newly described *C. a. distinctus* Ridgw. (Proc. Biol. Soc. Wash. xxi. 1908, p. 191—Rio Reventazón, near Guayábo, E. Costa Rica) is really distinct can, of course, only be decided when series from Panama and Eastern Costa Rica become available.

† Ridgway gives for Panama specimens the following measurements: wing, ♂ 79½, ♀ 77; tail, ♂ 65½, ♀ 66; bill 16, 16½ mm.

‡ *Pitangus parvus* Pelzeln, Zur Ornith. Bras. ii. pp. 111, 181 (1868.—Marabitanas, Rio Negro).

§ *M. xanthopygus aureatus* Bangs, Proc. New Engl. Zool. Cl. iv. p. 27 (1908.—Chiriqui).

|| Bull. U.S. Mus. no. 50, pt. iv. p. 490.

¶ Cfr. Hellmayr, Abhandl. Akad. Wiss. München, ii. Cl., xxii. 3, 1906, pp. 641-3.

Therefore, the natural affinities of these species are correctly expressed by the following scheme:—

- (a) *M. barbatus barbatus*: Guiana and Northern Brazil (Rio Negro, Borba, Pará, etc.).
- (b) *M. barbatus atricaudus*; Western Ecuador and Colombia, Panama, Costa Rica.
- (c) *M. barbatus mastacalis*: Eastern Brazil from Bahia to Rio, west to the Rio Madeira (*cfr.* Nov. Zool. xvii. 1910, p. 299).
- (d) *M. sulphureipygius sulphureipygius*: Southern Mexico; ? Guatemala, British Honduras.
- (e) *M. sulphureipygius aureatus*: From Honduras south to Panama.
- (f) *M. sulphureipygius villosus*: Western Colombia and Ecuador; ? Peru, N. Bolivia.

80. MYIOBIUS ERYTHRURUS FULVIGULARIS Salv. & Godm.

[*Myiobius erythrurus* Cabanis, Arch. f. Naturg. 13, i. p. 249, pl. 5, fig. 1 (1847.—Guiana, Cayenne).]

M. fulvicularis Salvín & Godman, Biol. Centr.-Amer., Aves, ii. p. 58 (1889.—Santa Fé, Veragua).

No. 2554. ♀ ad. Juntas, Rio Tamaná, 23.ii.09.—Wing 48; tail 36; bill $8\frac{1}{2}$ mm.

“Iris brown, feet yellow, maxilla black, mandible pink.”

This is an extreme example of *M. e. fulvicularis*, agreeing with skins from Costa Rica. The forehead is strongly washed with buff, the under parts are bright buffy ochreous, the throat lighter, more tawny, etc.

Cfr. my remarks in Nov. Zool. xiv. 1907, p. 48.

81. EMPIDONAX VIRESCENS Vieill.

Platyrrhynchos virescens Vieillot, Nouv. Dict. xxvii. p. 22 (1818—based on *Muscicapa querula* (nec Vieillot) Wilson, Amer. Orn. ii. 1810, p. 77, pl. 13, fig. 2—Eastern North America).

Empidonax acadicus auct. (nec Gmelin).

No. 2826. (♂) ad. Pueblo Rico: 5200 ft., 2.xi.09.—Wing 74; tail 62; bill 13 mm.

No. 2174. ♀ ad. Sipi: 9.x.08.—Wing 70; tail 59; bill 12 mm.

“Iris brown, feet dark grey, maxilla black, mandible yellow.”

A common winter visitor to the Western States of South America. It has several times been taken in Ecuador.

82. MYIOCHANES RICHARDSONII RICHARDSONII Swains.

Tyrannula richardsonii Swainson, Fauna Bor.-Amer. ii. p. 146, pl. 46, fig. inf. (1831.—Cumberland House, Saskatchewan, Canada).

No. —. ♀ ad. Loma Hermosa, 4150 ft.: 22.x.09.—Wing 80; tail 62; bill 12 mm.

"Iris dark brown, feet and bill black."

This species is also a regular winter visitor to Western South America. The specimen sent by Mr. Palmer agrees with others from Costa Rica (San José), Quito, etc.

83. MYIARCHUS CRINITUS Linn.

Turdus crinitus Linnæus, Syst. Nat. x. p. 170 (1758—*ex* Catesby, Carolina, i. p. 52, pl. 52 : Carolina).

Myiarchus crinitus Berlepsch, Journ. f. Ornith. 1884, p. 303 (Bucaramanga).

Nos. 2409, 2420. ♂♂ ad. Nóvita : 17, 21.xii.08.—Wing 101, 107 ; tail 92, 96 ; bill 21, 22 mm.

No. 2394. ♀ (?) ad. Nóvita : 12.xii.08.—Wing 106½ ; tail 98 ; bill 21 mm.

No. 2469. ♂ ad. Noanama : 13.i.09.—Wing 110 ; tail 102 ; bill 22 mm.

"Iris dark brown, feet black, maxilla black, mandible horn-brown."

These birds are absolutely identical with skins from the Eastern United States. From *M. tyrannulus* (P. L. S. Müll.) they differ in being decidedly greenish instead of greyish brown above, in the darker cinereous throat and chest, much deeper yellow belly, and in having the whole of the inner web of the outer rectrices rufous.

The present record extends the range of *M. crinitus* in its winter quarters considerably to the south. The most southerly locality yet known was Bucaramanga, whence Lorentz had sent a specimen to the Bremen Museum (*cfr.* Berlepsch, l. c. p. 303).

84. MYIARCHUS NIGRICEPS ScL.

Myiarchus nigriceps Sclater, P. Z. S. 1860, p. 68 (1860.—Pallatanga, W. Ecuador).

No. 2809. (♂) ad. Pueblo Rico, 5200 ft. : 25.x.09.—Wing 82 ; tail 75 ; bill 18 mm.

No. 2208. ♂ imm. Noanama : 21.x.08.—Wing 77 ; tail 73 ; bill 18 mm.

"Iris dark brown, feet and bill black."

The two skins agree with topotypical examples from Western Ecuador. The pileum is uniform deep black.

Mr. Ridgway, in his great work *, has again confounded two distinct species under the name *M. nigriceps*, overlooking my remarks in Nov. Zool. xiii. 1906, p. 23 & pp. 323-4. I think I have conclusively shown that the birds from Venezuela, Amazonia, and Guiana belong to *M. tuberculifer*, while *M. nigriceps* is restricted to Panama, W. Colombia, W. Ecuador, and Northern Peru.

The range of the two species is given *in extenso* in Nov. Zool. xiii. p. 26.

* Bull. U.S. Mus. no. 50, pt. iv. p. 650.

85. *TYRANNUS MELANCHOLICUS SATRAPA* Cab. & Heine.

[*Tyrannus melancholicus* Vieillot, Nouv. Dict. xxxv. p. 84 (1819.—*ex* Azara: Paraguay).]

Laphyetes satrapa Cabanis & Heine, Mus. Hein. ii. p. 77 (1859.—“Guiana and Carácas”).

Tyrannus melancholicus (nec Vieillot) Sclater & Salvin, P. Z. S. 1879, p. 516 (Retiro, Medellín); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 143 (Turbo, Carthage, R. Truando).

No. 2712. ♂ ad. Tadó, 230 ft., 17.vi.09.—Wing 116; tail 101; bill 21 mm.

“Iris dark brown, feet and bill black.”

86. *CHLOROPIPO HOLOCHLORA LITÆ* Hellm.

[*Chloropipo holochlora* Sclater, Cat. B. Brit. Mus. xiv. p. 287 (1888.—Bogotá).]

Chloropipo holochlora litæ Hellmayr, Nov. Zool. xiii. p. 325 (1906.—Lita, N.W. Ecuador).

C. holochlora (nec Sclater) Sclater, Cat. B. Brit. Mus. xiv. p. 287 (part.: specimen *b*, “Pasto,” Colombia); Hartert, Nov. Zool. v. 1898, p. 488 (Cachabi, Paramba, N.W. Ecuador).

No. 2081. ♂ ad. Sipi: 12.x.08.—Wing 69; tail 44; bill $10\frac{1}{2}$ mm.

No. 2352. (♂) ad. Nóvita: 30.xi.08.—Wing 71; tail 46; bill $11\frac{1}{3}$ mm.

No. 2112. ♀ ad. Sipi: 23.ix.08.—Wing $66\frac{1}{2}$; tail 43; bill 11 mm.

“Iris brown, feet grey or blackish, maxilla black, mandible grey.”

Identical with topotypical skins from North-western Ecuador. The upper parts are light olivaceous green, the throat, chest, and sides somewhat duller. On the eastern (Amazonian) slope of the Colombian and Ecuadorian Andes this form is replaced by typical *C. h. holochlora*.

The locality “Pasto” requires confirmation. The specimen is typical of *C. h. litæ*.

C. h. litæ is restricted to the lowlands and foot-hills of W. Colombia and N.W. Ecuador.

87. *MASIUS CHRYSOPTERUS BELLUS* Hart. & Hellm.

[*Pipra chrysoptera* Lafresnaye, Rev. Zool. vi. p. 97 (1843.—Bogotá).]

Masius chrysopterus bellus Hartert & Hellmayr, Orn. Monatsber. xi. p. 35 (1903.—Riolima, Cauca Valley, 4000 ft.).

M. coronulatus (nec Sclater) Sclater & Salvin, P. Z. S. 1879, pp. 516, 549 (Antioquia; no exact locality); Pelzeln & Madarász, Monogr. Pipr. pl. v. (figure of the Antioquia specimen).

No. —. ♂ ad. Pueblo Rico, 5200 ft., 28.x.08.—Wing 59; tail 43; bill 7 mm.

"Iris brown, feet light red, maxilla light grey, mandible pale red."

This specimen confirms the characters of the subspecies originally based upon a male obtained by the late J. H. Batty in the same region. The feathers of the coronal crest, which have exactly the same shape as in *M. c. coronulatus* of Western Ecuador, being thickened at the end into a horny substance, are dark brownish red instead of light tobacco-brown.

M. c. bellus is well figured in Pelzeln and Madarász's Monograph of the Pipridæ, on plate v. In their joint communication* Hartert and Hellmayr have pointed out that Salmon's Antioquia specimen belongs to this form, calling attention to a misleading statement in Sclater and Salvin's report in P. Z. S. 1879. *M. c. bellus* is as yet known only from the Western Cordillera of Colombia.

88. PIPRA MENTALIS MINOR Hart.

[*Pipra mentalis* Sclater, P. Z. S. 1856, p. 299, pl. 121 (1857. —Cordova, Vera Cruz, Mexico).]

Pipra mentalis minor Hartert, Nov. Zool. v. p. 489 (1898. —Cachabi, N.W. Ecuador).]

No. 2225. ♂ ad. Rio Cajón: 31.x.08.—Wing 60; tail 29; bill 8 mm.

No. 2098. ♂ ad. Sipi: 21.ix.08.—Wing 60; tail 29; bill $8\frac{1}{2}$ mm.

Nos. 2002, 2201. ♂ ♂ ad. Noanama: 22.viii, 19.x.08.—Wing 58, 57; tail 28, 29; bill 8, $8\frac{1}{2}$ mm.

Nos. 2207, 2308, 2380. 2371. ♂ ♂ ad. Nóvita: 18, 19.xi., 5, 9.xii.08.—Wing 57–58; tail 28–29; bill 8 mm.

Nos. 2030, 2192, 2430. ♂ ♂ juv. (plumage of female). Noanama: 27.viii.; Sipi: 14.x.; Nóvita: 23.xii.08.—Wing 60; tail 29– $30\frac{1}{2}$; bill $8\frac{1}{2}$ –9 mm.

Nos. 2172, 2226. ♀ ♀ ad. Sipi: 9.x.08; Rio Cajón: 31.x.08.—Wing 59; tail 28, $30\frac{1}{2}$; bill $8\frac{1}{2}$ –9 mm.

"Iris white (in adult male), dark brown (in females and young males), feet light brown or grey, maxilla dark brown, mandible pale brown or pink."

The adult males agree, so far as coloration is concerned, with typical birds from Northern Ecuador. The head is of the same intense crimson hue, the gonydeal angle is but narrowly edged with yellowish, and the inner secondaries only have slight yellowish-white margins along the inner web. While the bill is as small and short as in Ecuador specimens, in the length of the wing and tail the Colombian birds approach *P. m. ignifera*, from Chiriqui and Costa Rica. The difference in size, however, is very slight and not constant enough to warrant their separation from *P. m. minor*. Ten adult males from Western Ecuador

* Ornithologische Monatsberichte, xi. pp. 33–35.

(including type) measure as follows :—wing 55 (twice) to 58; tail 26–28; bill 8–9 mm.

P. m. minor thus ranges from Ecuador northwards over the Pacific lowlands of Western Colombia.

89. PIPRA CORONATA VELUTINA Berl.

[*Pipra coronata* Spix, Av. Bras. ii. p. 5, pl. vii. fig. 1 (1825.—S. Paulo d'Oliveira).]

Pipra velutina Berlepsch, Ibis, 1883, p. 492 (1883.—Veragua).

P. cyaneocapilla (nec Hahn) Selater & Salvin, P. Z. S. 1879, p. 517 (Medellin, Remedios, R. Neche, Antioquia).

Nos. 2301, 2316, 2340, 2365, 2401. ♂ ♂ ad. Nóvita: 17, 20, 26.xi., 3, 15.xii.08.

Nos. 2118, 2105, 2146, 2156, 2182, 2241. ♂ ♂ ad. Sipi: 22, 24.ix., 1, 2, 3, 12.x.08.

No. 2030. ♂ ad. Noanama: 26.xi.08.

No. 2239. ♂ ad. Rio Cajón: 4.xi.08.

Nos. 2031, 2040, 2058, 2216. ♂ ♂ juv. Noanama: 28, 31.viii., 4.ix., 22.x.08.

No. 1964. ♂ juv. S. Joaquim: 4.viii.08. No. 2160. ♂ juv. Sipi: 6.x.08.

Nos. 2311, 2334, 2361, 2362, 2366. ♀ ♀ ad. Nóvita: 19, 24.xi., 1, 3.xii.08.

Nos. 2121, 2124, 2173. ♀ ♀ ad. Sipi: 25, 28.ix., 9.x.08.

No. 1965. ♀ ad. S. Joaquim: 4.viii.08.

“Iris dark red (in adult males), dark brown (in females and young males), feet black, maxilla black, mandible blue.”

♂ ♂ ad.: wing $55\frac{1}{2}$ –58; tail 24–26; bill 7–8 mm.

♀ ♀ ad.: wing 55–58; tail 25–28; bill $7\frac{1}{2}$ – $8\frac{1}{2}$ mm.

In ‘The Ibis’ for 1906, pp. 31–32, I have already alluded to the smaller size of specimens from N.W. Ecuador and Western Colombia. All of the many skins procured by Mr. Palmer have much smaller bills and decidedly shorter wings than a series from Chiriqui and Costa Rica. In the adult males the black of the plumage is also somewhat deeper. Although I feel pretty sure that the southern birds constitute a separable race, yet I should like to examine a series from Veragua, the type-locality, before making any formal separation.

Specimens from different localities measure as follows:—

Males.	Wing. mm.	Tail. mm.	Bill. mm.
10: Chiriqui	62–64	27–29	$9-9\frac{1}{2}$
4: W. Costa Rica.....	62–64	27–28	$9-9\frac{1}{2}$
3: Panama (Railway)	58–59	26–27	$7-7\frac{1}{2}$
14: W. Colombia	55–58	$24\frac{1}{2}$ –26	7–8
7: N.W. Ecuador	55–57	25–27	$7\frac{1}{2}$ –8
Females.			
4: Chiriqui and Costa Rica.....	$61\frac{1}{2}$ –63	28–30	$9\frac{1}{2}$ –10
10: W. Colombia	$54\frac{1}{2}$ –57	25–27	$7\frac{1}{2}$ –8
3: N.W. Ecuador	55–56	26	7–8

90. *CHIROMACHÆRIS VITELLINA* Gould.

Pipra vitellina Gould, P. Z. S. 1843, p. 103 (Dec. 1843.—Panama).

Chiromachæris vitellina Sclater & Salvin, P. Z. S. 1879, p. 516 (Cauca, Remedios).

Nos. 2025, 2097, 2364, 2494. ♂ ♂ ad. Noanama: 28.viii; Sipi: 21.ix; Nóvita: 3.xii.08, 27.i.09.—Wing 53–54; tail 28–30; bill 10 mm.

Nos. 2067, 2185. ♂ ♂ juv. Noanama: 5.ix.08; Sipi: 13.x.08.

Nos. 2352, 2439. ♀ ♀ ad. Nóvita: 30.xi., 28.xii.08.—Wing 54–55; tail 29; bill 10 mm.

“Iris dark brown, feet orange, bill black”

A single male from Panama is rather more yellowish green on the belly, but does not differ otherwise. *C. aurantiaca* Salv. is apparently the geographical representative of *C. vitellina* in Veragua and S.W. Costa Rica.

C. vitellina ranges from the Isthmus of Panama south to W. Colombia.

91. *SAPAYOA ÆNIGMA* Hart.

Sapayoa ænigma Hartert, Nov. Zool. x. p. 117 (1903.—Rio Sapayo, N.W. Ecuador); Hellmayr in Wytsman's Genera Avium, part ix. 1910, p. 28, pl. i. figs. 5, 8.

No. 2418. ♂ ad. Nóvita: 19.xii.08.—Wing 82; tail 66; bill 15 mm.

No. 2070. ♂ juv. Noanama: 1.ix.08.—Wing 81; tail 61; bill $13\frac{1}{2}$ mm.

Nos. 2071, 2457. ♀ imm., ♀ ad. Noanama: 5.ix.08, 9.i.09.—Wing 82, 79; tail 59; bill 15 mm.

“Iris brown, feet black, bill black, mandible grey in adult male and females, yellow in the young male” (no. 2070).

This curious bird was hitherto represented only by a single female, the type, from N.W. Ecuador, in the Tring Museum. It has been fully described by Hartert, and I have nothing to add to his excellent account. *Sapayoa* is certainly related to *Scotothorus*, though the shape of the bill, the feathering of the upper portion of the metatarsus etc., serve to distinguish it at a glance.

The females agree exactly with the type, while the adult male differs in having the middle of the crown bright golden yellow. The tail is longer, with the rectrices decidedly narrower, and the central pair slightly elongated, exceeding the submedian one by about 3 mm. The immature female has the upper part of the head more yellowish green, and the throat slightly paler yellowish than the adults. The young male (without any trace of the golden yellow crown-patch) has a much shorter, smaller bill, with the lower mandible yellowish white instead of brownish horn-colour. The range of *S. ænigma* is restricted to the humid lowlands of the Pacific coast of N.W. Ecuador and W. Colombia.

92. *TITYRA SEMIFASCIATA COLUMBIANA* Ridgw.

[*Pachyrhynchus semifasciatus* Spix, Av. Bras. ii. p. 32, pl. xlv. fig. 2 (1825.—Pará).]

Tityra semifasciata columbiana Ridgway, Proc. Biol. Soc. Wash. xix. p. 119 (1906.—La Concepción, Santa Marta).

T. personata (nec Jardine & Selby) Sclater & Salvin, P. Z. S. 1879, p. 517 (Remedios, Neche).

No. 2502. ♂ ad. Nóvita: 29.i.09.—Wing 122; tail 77; bill 24 mm.

No. 2314. ♀ ad. Nóvita: 19.xi.08.—Wing 114; tail 69; bill 24 mm.

“Iris red-brown (♂), dark-brown (♀), feet dark grey, bill red, tip black.”

As correctly pointed out by Mr. Ridgway, the adult male differs from typical *T. semifasciata* of Amazonia* by the much narrower black frontal area, the posterior margin of which ends in a line with the middle of the eye, instead of extending as far as its posterior edge. Moreover, the black band across the inner web of the outer rectrices is much broader, and reaches nearly or quite to the shaft. The female is much browner on the upper parts, with the pileum considerably darker.

By the coloration of the female, and the greater extent of black on the lateral rectrices, this form approaches *T. s. costaricensis* Ridgw.† from Panama and Costa Rica, which, however, is smaller and has even more black in the tail.

T. s. columbiana ranges from Santa Marta through Western Colombia to the province of Esmeraldas, N.W. Ecuador. Specimens from the latter locality agree in every respect with the Colombian ones.

93. *TITYRA ALBITORQUES ALBITORQUES* Dubus.

Tityra albitorques Dubus, Bull. Acad. Roy. Belg. xiv. pt. ii. p. 104 (1847.—Peru); Sclater & Salvin, P. Z. S. 1879, p. 517 (Remedios).

Nos. 2278, 2452. ♂♂ ad. Nóvita: 13.xi.08; Noanama: 7.i.08.—Wing 107, 105; tail 67; bill $21\frac{1}{2}$, $22\frac{1}{2}$ mm.

No. 2525. ♂ ad. El Tigre, R. Tamaná: 10.ii.09.—Wing 103; tail 64; bill 22 mm.

No. 2524. ♀ ad. El Tigre: 9.ii.09.—Wing 100; tail 64; bill 22 mm.

“Iris dark brown, feet grey, bill black.”

The males do not appear to be different from those obtained by Natterer at Manãos, N. Brazil, or from an adult male from

* Mr. Ridgway (Bull. U. S. Mus. no. 50, pt. iv. p. 868) gives as its range “Southern Brazil and Bolivia to Central Colombia.” This is not quite correct, for *T. s. semifasciata* is strictly an Amazonian species, ranging from Pará west to the Eastern slopes of the Andes, south to E. Bolivia and W. Matto Grosso.

† Proc. Biol. Soc. Wash. xix. p. 119 (1906.—Bonilla, Costa Rica).

Chyavetas, N. Peru. The back, upper wing- and tail-coverts are pale pearl-grey, the basal half of the rectrices greyish white, the remaining portion black with a distinct white apical margin, the ear-coverts white, etc., exactly as in the skins from Manáos and Peru.

T. buckleyi Salv. & Godm. * from Eastern Ecuador, the type of which I have examined in the British Museum, may be distinguished by the paler, nearly white colour of the upper wing-coverts and rump, by having the white in the tail confined to the extreme base of the outer web of the external rectrices, etc. etc.

94. PLATYPSARIS HOMOCHROUS ScL.

Pachyrhamphus homochrous Selater, P. Z. S. 1859, p. 142 (1859.—Pallatanga, W. Ecuador).

Hadrostomus homochrous Selater & Salvin, P. Z. S. 1879, p. 517 (Remedios).

Nos. 2260, 2600, 2685. ♂♂ ad. Nóvita: 10.xi.; Condoto: 14.iv.09; Tadó: 2.vi.09.—Wing 90; tail 63–65; bill 16–17 mm.

No. 2415. ♂ juv. Nóvita: 19.xii.08.—Wing 86; tail 61; bill 17 mm.

No. 2399. ♀ ad. Nóvita: 17.xii.08.—Wing 85; tail 61; bill 17 mm.

"Iris dark brown, feet blue-grey, bill black, mandible grey in the young male and female."

Identical with skins from N.W. Ecuador, province of Esmeraldas.

This species ranges from Panama (Railroad) and Santa Marta in the north through Western Colombia and Western Ecuador to N.W. Peru (Lechugal, district of Tumbes) †.

95. PACHYRHAMPHUS DORSALIS ScL.

Pachyrhamphus dorsalis Selater, Cat. Amer. B. p. 243 (1862.—"Bogotá?" ‡); Ridgway, Bull. U. S. Mus. no. 50, pt. iv. 1907, p. 832 (Rio Cali, R. Barratoro, Castilla, W. Colombia); Bangs, Proc. Biol. Soc. Wash. xxi. 1908, p. 157 ("N.W. Colombia, just south of Darien," errore; see footnote above p. 1085).

P. cinereiventris (nec Selater) Selater & Salvin, P. Z. S. 1879, p. 518 (Santa Elena).

No. 3750. ♀. Pueblo Rico, 5200 ft., 11.ix.09.—Wing 75; tail 57; bill $13\frac{1}{2}$ mm.

"Iris brown, feet dark grey, bill black."

* Biol.-Centr. Amer., Aves, ii. p. 120 (Dec. 1890.—Yanayacu, Ecuador).

† The locality "Sarayaçu," East Ecuador, is undoubtedly incorrect. I have, on several occasions, alluded to the fact that Buckley's localities cannot be relied upon, collections from the western and eastern slopes of the Andes having been mixed up and almost invariably labelled "Sarayaçu."

‡ I have examined the type in the British Museum. It is an undoubted Bogotá skin.

I quite agree with Mr. Ridgway in considering this species totally different from *P. niger cinereiventris* Scl., with which Dr. Sclater later united it. In fact, *P. dorsalis* appears to be the Western representative of *P. marginatus* Licht.* It may, however, readily be distinguished in the male sex by the uniform black upper back, separated from the glossy black pileum by a very broad, light cinereous nape-band. The wings and tail are longer, and the bill decidedly larger.

The female, as yet undescribed, is very much like that of *P. marginatus*, but has a larger, broader bill, and the pileum is dark olive, each feather with an apical spot of dull greenish black.

In addition to the type and another specimen in the British Museum, I have examined four more adult males from Bogotá in the collections of the Munich Museum and of Count Berlepsch. The Tring Museum possesses specimens from Paramba, N.W. Ecuador, which are perfectly similar to Bogotá skins.

P. dorsalis thus ranges from Panama through Western Colombia to N.W. Ecuador.

96. *PACHYRHAMPHUS CINNAMOMEUS* LAWY.

Pachyrhamphus cinnamomeus Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 295 (Jan. 1861.—Lion Hill Station, Panama Railway).

Pachyrhamphus cinnamomeus Sclater & Salvin, P. Z. S. 1879, p. 518 (Remedios).

P. rufescens? Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 189 (Turbo).

Nos. 1980, 2535. ♂♂ ad. Guineo: 8.viii.08; El Tigre, 320 ft.: 12.ii.09.—Wing 78, 79; tail 57, 55; bill $14\frac{1}{2}$ mm.

Nos. 1968, 2034. ♂♂ imm. (without the rudimentary second primary). S. Joaquim, Bahia del Chocó, 4.viii; Noanama: 29.viii.08.—Wing 75, 79; tail 57; bill 14 mm.

Nos. 2026, 2350. ♀♀ ad. Noanama: 28.viii.; Nóvita: 28.xi.08.—Wing 75, 76; tail 55, 58; bill 14 mm.

"Iris dark brown, feet blue-grey, maxilla black, mandible blue."

The series is exactly like specimens from Western Ecuador, while skins from Central America (Costa Rica, Guatemala), as a rule, are of a deeper rufous-tawny on the upper parts.

P. cinnamomeus ranges from Southern Mexico (Tabasco) and Guatemala southwards to Western Ecuador †.

97. *LATHRIA UNIRUFA CASTANEOTINCTA* Hart.

[*Lipaugus unirufus* Sclater, P. Z. S. 1859, p. 385 (1860.—Oaxaca, S. Mexico, and Guatemala).]

* = *P. atricapillus* auct. (nec Merrem); cfr. Berlepsch, Nov. Zool. xv. 1908, p. 141.

† In Upper Amazonia (Eastern Ecuador; Ucayali, Peru) its place is taken by another form, closely allied to, or perhaps even identical with, *P. castaneus* Jard. & Selby. [= *P. rufus* auct. nec Boddaert.]

Lathria unirufus castaneotinctus Hartert, Nov. Zool. ix. p. 610 (1902.—Rio Durango, N.W. Ecuador).

Lathria unirufa (nec Sclater) Hartert, Nov. Zool. v. 1898, p. 490 (Cachabi, N.W. Ecuador); Sclater & Salvin, P. Z. S. 1879, p. 518 (Remedios, Neche).

Lipaugus unirufus (nec Sclater) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 143 (Turbo, R. Truando).

Nos. 2306, 2315, 2045, 2175. ♂ ♂ ad. Nóvita: 18, 20.xi.; Noanama: 1.ix.08; Sipí, Río Sipí: 10.x.08.—Wing 130–135; tail 102–108; bill 20–21 mm.

Nos. 2217, 2342, 2343, 2423. ♀ ♀ ad. Cajón, R. Cajón: 28.x.08; Nóvita: 27.xi., 22.xii.08.—Wing 123–128; tail 101–105; bill 20–21 mm.

“Iris dark brown, feet grey, maxilla brown, mandible pale brown or grey.”

These specimens agree with topotypical birds from N.W. Ecuador and differ from *L. u. clara* Ridgw.* of southern Central America, in having the back decidedly brighter, more cinnamon-rufous, and the under parts also darker, deep tawny-ochraceous. The bill also is light brown instead of blackish horn-colour.

The specimens from Antioquia (Remedios, Neche) in the British Museum likewise belong to this form; and so probably also do those obtained by Lieut. Michler's expedition to the Río Truando (although they are referred by Mr. Ridgway† to *L. u. clara*), since the fauna of the Atrato region is essentially identical with that of the Chocó district.

L. u. castaneotincta, therefore, appears to range from the coast of the gulf of Uraba through Western Colombia to the province of Esmeraldas, N.W. Ecuador.

98. *LIPAUGUS HOLERYTHRUS ROSENBERGI* Hart.

[*Lipaugus holerythrus* Sclater & Salvin, P. Z. S. 1860, p. 300 (1860.—Vera Paz, Guatemala).]

Lipaugus holerythrus rosenbergi Hartert, Bull. B. O. C. xvi. p. 12 (1905.—Río Dagua, W. Colombia).

Lipaugus holerythrus (errore) Hartert, Nov. Zool. v. 1898, p. 489 (Cachabi, N.W. Ecuador).

Nos. 2355, 2375. ♂ ♂ ad. Nóvita: 30.xi., 7.xii.08.—Wing 104, 102; tail 90, 89; bill 19, 20 mm.

No. 2100. ♀ ad. Sipí, Río Sipí: 21.ix.08.—Wing 102; tail 90; bill 19 mm.

“Iris dark brown, feet dark grey or black, maxilla blackish, mandible brown.”

These birds, which are to be regarded as topotypical of *L. u. rosenbergi*, differ from Central American skins in their darker

* Proc. Biol. Soc. Wash. xix. p. 120 (1906.—Lion Hill, Panama).

† Bull. U. S. Mus. no. 50, pt. iv. p. 824.

tawny russet upper, and deeper tawny under parts, as correctly pointed out by Hartert.

Although I have not seen the examples from Antioquia (Nèche, Remedios *), I have little doubt that they also are referable to the present form rather than to typical *L. h. holerythrus*.

L. h. rosenbergi is another of the many species peculiar to Western Colombia and N.W. Ecuador (province Esmeraldas).

99. COTINGA NATTERERII Boiss.

Ampelis nattererii Boissonneau, Rev. Zool. iii. p. 2 (1840.—Santa-Fé-de-Bogotá).

Cotinga nattererii Ridgway, Bull. U. S. Mus. no. 50, pt. iv. 1907, p. 785 (Eastern Panama (Railway line) to Colombia; crit.).

Cotinga simoni Berlepsch, Ornith. xiv. p. 361 (1907.—San José, Rio Dagua, W. Colombia).

Nos. 2267, 2268, 2269, 2281, 2283, 2289, 2290, 2291, 2292. ♂ ♂ ad. Nóvita, Rio Tamaná: 12, 14, 16.xi.08.—Wing 107–111; tail 66–69; bill $14\frac{1}{2}$ – $15\frac{1}{2}$ mm.

No. 2270. ♂ imm. Nóvita: 12.ix.08.—Wing 108; tail 67; bill $15\frac{1}{2}$ mm.

Nos. 2282, 2293. ♂ ♂ juv. Nóvita: 14, 16.xi.08.—Wing 105; tail 68, 70; bill 14, 15 mm.

Nos. 2271, 2275, 2284, 2294, 2295, 2296. ♀ ♀ ad. Nóvita: 12, 13, 14, 16.xi.08.—Wing 106–110; tail 71–75; bill $14\frac{1}{2}$ –15 mm.

“Iris black, feet dark grey, maxilla black, mandible blue.”

The series of adult males is fairly uniform, the variation being chiefly confined to the intensity of the purple colour of the throat and abdominal patch. Two specimens, especially nos. 2281, 2291, have the throat darker than the others. All, however, show the characteristic blackish cross-bars (which sometimes have a slight metallic greenish sheen) to the feathers of the throat, already noticed by M. Boissonneau and more fully described by Mr. Ridgway, and the pale cerulean blue border to the gonydeal angle; the pileum is constantly deeper blue than the back; the second primary is very nearly as long as the third, and never attenuated on its apical portion, so striking a feature in the allied *C. ridgwayi* Ridgw., from Chiriqui and S.W. Costa Rica.

I am sorry to say that *C. simoni* is clearly a synonym of *C. nattererii*, for the description of Boissonneau, which Count Berlepsch appears to have overlooked, corresponds exactly to the Chocó birds.

I do not understand the Count's statement as regards the coloration of the female which, he says, resembles that of

* *L. holerythrus* Scater & Salvin, P. Z. S. 1879, p. 519 (Nèche); See also, Cat. B. xiv. 1888, p. 357 (part.: Remedios, Nèche).

C. cayana. As a matter of fact, the six females obtained by Mr. Palmer are exactly like *C. ridgwayi* except in being slightly deeper buff on the anterior under parts. In the main features, viz., crown and back sooty edged with buffy white, larger upper wing coverts broadly margined with cinnamon-buff, dusky markings of lower surface etc., the females of the two species are practically identical.

C. nattererii ranges from Eastern Panama (Railway line) south to Buenaventura, Western Colombia. Occasionally it is also met with in Bogotá collections.

100. CARPODECTES HOPKEI Berl.

Carpodectes hopkei Berlepsch, Orn. Monatsber. v. p. 174 (1897.—San José. R. Dagua, W. Colombia); Hartert, Nov. Zool. ix, 1902, p. 611 (Ventana, N.W. Ecuador).

Nos. 2205, 2272, 2285, 2286, 2287, 2288. ♂♂ ad. & imm. Nóvita: 12, 14, 18.xi.08.—Wing 158–170; tail 95–102; bill 20–21½ mm.

No. 2273. (♂) juv. Nóvita: 12.xi.08.—Wing 158; tail 92; bill 20 mm.

Nos. 2303, 2325, 2326, 2335, 2339. ♀♀ ad. & imm. Nóvita: 17, 23, 25, 26.xi.08.—Wing 135–140; tail 84–87; bill 18–19 mm.

No. 2274. (♂) juv. Nóvita: 12.xi.08.—Wing 154; tail 100; bill 18 mm.

“Iris orange (or orange-yellow), feet and bill black.”

“I have seen, but been unable to shoot this bird in all parts of the Chocó from Malaquita (S. T.) up to Sipi” (M. G. Palmer).

The series of males illustrates beautifully the variation according to age. In perfectly adult birds the six outer primaries and the central pair of rectrices bear only a small, rounded black spot at the tip, while the plumage otherwise is pure white, sometimes with a scarcely perceptible greyish tinge on the pileum. Immature males have much more black on the wings, and most, if not all, of the rectrices tipped with black. The younger the bird, the more extended is the black colour. No. 2287 has not only the black tips to the three outer primaries much larger than the specimens in more advanced stage, but the greater part of the inner web of the remaining primaries is also black. The shafts of the primaries are pure white in adult, black in immature males. The latter, besides, have the bastard-quills and primary coverts edged or tipped with black.

No. 2273 is changing from the grey juvenile plumage into the white of the adult. Another, still younger, male, No. 2274, resembles the females, but may be distinguished by its larger size, much paler cinereous upper parts and breast, whiter belly, etc. A specimen in the Tring Museum from Ventana, N.W. Ecuador, is exactly like it.

C. hopkei is peculiar to the hot, forest-covered lowlands of

Western Colombia and the adjoining parts of Ecuador (province Esmeraldas).

101. *QUERULA PURPURATA* P. L. S. Müll.

Muscicapa purpurata P. L. S. Müller, Natursyst. Suppl. p. 169 (1776—ex Daubenton, Pl. Enl. 381: Cayenne).

Querula cruenta Cassin, Proc. Acad. Philad. 1860, p. 143 (Turbo); Sclater & Salvin, P. Z. S. 1879, p. 520 (Pocune, Remedios).

Nos. 2001, 2151, 2265. ♂♂ ad. Noanama: 22.viii.; Sipi: 3.x.; Nóvita: 12.xi.08.—Wing 178–182; tail 114–117; bill 24 mm.

Nos. 2044, 2152, 2266. ♀♀ Noanama: 1.ix.; Sipi: 3.x.; Nóvita: 12.xi.08.—Wing 166–168; tail 108–112; bill 22–23½ mm.

“Iris dark brown, feet black, bill blue.”

These birds have generally smaller bills than those from Guiana, Venezuela (Caura) and Pará, but the difference is not quite constant. This is a wide-spread species, ranging from Costa Rica to Peru, and the mouth of the Amazons.

102. *SYNALLAXIS PUDICA* ScL.

Synallaxis pudica Sclater, P. Z. S. 1859, p. 191 (1859.—Bogotá); Sclater & Salvin, P. Z. S. 1879, p. 521 (Remedios, Antioquia).

No. 2116. ♀ ad. Sipi: 26.ix.08.—Wing 60; tail 73; bill 15 mm.

No. 2730. ♀ juv. Pueblo Rico, 5200 ft.: 16.viii.09.

“Iris brown, feet blue-grey (no. 2116), dark brown (no. 2730), bill black, mandible grey.”

Identical with specimens from Bogotá collections.

103. *SYNALLAXIS UNIRUFA* Lafr.

Synallaxis (sic) *unirufa* Lafresnaye, Rev. Zool. vi. p. 290 (1843.—“Colombia”).

Synallaxis unirufa Sclater & Salvin, P. Z. S. 1879, p. 521 (Antioquia).

No. —. ♂ ad. Tatamá Mountain, 6700 ft., 9.x.09.—Wing 61; tail 70 mm.; bill damaged.

“Iris brown, feet dark grey, bill black.”

Agreeing with a Bogotá skin. The plumage is uniform clear chestnut rufous, rather paler underneath, except, of course, the blackish inner webs of the remiges. There is no black gular patch, so characteristic a feature in the allied *S. castanea* ScL.* from the Silla de Caraccas, Venezuela.

S. unirufa is peculiar to the high mountains of Colombia.

* Ann. Mag. Nat. Hist. (2) xvii. p. 466 (1856.—Caraccas).

104. *SIPTORNIS ERYTHROPS GRISEIGULARIS* Ridgw.

[*Synallaxis erythrops* Sclater, P. Z. S. 1860, p. 66 (1860.—Pallatanga, W. Ecuador).]

Acroorchilus erythrops griseigularis Ridgway, Proc. Biol. Soc. Wash. xxii. p. 72 (1909.—San Antonio, Rio Cali, "N.W." Colombia; M. G. Palmer coll.).

Synallaxis erythrops (nec Sclater) Sclater & Salvin, P. Z. S. 1879, p. 521 (Frontino, W. Cordillera).

Nos. 3740, —. ♂♂ ad. Pueblo Rico (5200 ft.), 7.ix.; Siató (5200 ft.), ix.09.—Wing 69; tail 63, 65; bill 13 mm.

No. 2799. ♀ juv. Loma Hermosa, R. Jamaraya (4150 ft.), 18.x.09.—Wing 63; tail 68; bill 13 mm.

"Iris brown, feet greyish green, maxilla black, mandible light brown."

The adult birds fully bear out the characters given by Mr. Ridgway for his subspecies which, moreover, was based upon one of Palmer's skins. *S. e. griseigularis* may easily be recognized from its allies: *S. e. erythrops* Scl., of Western Ecuador, and *S. e. rufigenis* Lawr.*, of Chiriqui and Costa Rica. by its mouse-grey (instead of buffy brown) foreneck and breast, and brighter cinnamon-rufous median rectrices.

S. e. griseigularis is peculiar to the elevated districts of the Western Cordillera of Colombia.

[105. *THRIPADECTES SCLATERI* Berl.

Thripadectes sclateri Berlepsch, Ornith. xiv. p. 365 (Feb. 1907.—S. Pablo, W. Colombia, 4500 ft.; G. Hopke coll.).

Rhopoctites alogus Bangs, Proc. Biol. Soc. Wash. xxiii. p. 72 (1910.—Pavas, W. Colombia, 4400 ft.; M. G. Palmer coll.).

Count Berlepsch having kindly submitted to my inspection the type specimen, I can positively state that *R. alogus* is merely a synonym of *T. sclateri*, the description of which appears to have been overlooked by Mr. Bangs. The two types were obtained in the same district, viz., in the Western Cordillera above Buenaventura, Chocó Bay. Although somewhat resembling *Automolus* (*Rhopoctites*) *rufobrunneus* in general coloration, *T. sclateri* is a very distinct species, and I agree with its describer that it finds its natural place in the genus *Thripadectes*. The structural characters, especially the shape and size of the bill, are exactly the same as in *T. flammulatus*, while *A. rufobrunneus* has a much shorter, slenderer, more depressed bill, and much shorter, weaker tarsi. The pileum has distinct, though narrow, pale shaft-lines, whereas it is uniform dusky olive in *A. rufobrunneus*; the back is darker, less reddish; the throat much paler, light ochraceous instead of deep orange; the sides of the neck are olive-brown instead of orange-ochraceous; the breast and abdomen are darker ochraceous

* *Synallaxis rufigenis* Lawrence, Ann. Lyc. N. H. N.Y. ix. p. 105 (1868.—Costa Rica).

and lack the pale shaft-stripes, so conspicuous in *A. rufobrunneus*, etc. etc.

The type, an adult female, obtained by the late Gustav Hopke, March 6, 1897, measures—wing 99; tail 95; bill 27 mm.]

106. AUTOMOLUS NIGRICAUDA Hart.

Automolus nigricauda Hartert, Bull. B. O. C. vii. p. xxx. (1898.—Cachabi, N.W. Ecuador); idem, Nov. Zool. v. 1898, p. 491 (Cachabi); idem, l. c. ix. 1902, p. 616 (Paramba, 3500 ft.; Rio Sapayo, 450 ft.: N.W. Ecuador).

No. 2414. ♂ ad. Névita, 150 ft., 18.xii.08.—Wing 83; tail 71; bill 23 mm.

“Iris light brown, feet and bill black.”

This bird is practically identical with the specimens in the Tring Museum. The species was hitherto known only from N.W. Ecuador, where Mr. Rosenberg and his collectors obtained three examples at Cachabi (500 ft.), Paramba (3500 ft.), and Rio Sapayo (450 ft.).

A. nigricauda is nearly allied to the group of *A. rubiginosus* from Central America, but may easily be distinguished by its dull blackish (instead of bright chestnut rufous) tail, less rufous wings, darker ferruginous foreneck, dull brownish olive belly, etc., etc.

107. HYLOCTISTES SUBULATUS ASSIMILIS Berl. & Tacz.

[*Sphenura subulata* Spix, Av. Bras. i. p. 82, pl. lxxxiii. fig. 1 (1824—“in sylvis fl. Amazonum”).]

Automolus assimilis Berlepsch & Taczanowski, P. Z. S. 1883, p. 561 (1883.—Chimbo, S.W. Ecuador); Hartert, Nov. Zool. v. 1898, p. 491 (Chimbo, Cachabi, W. Ecuador).

No. 2080. ♂ (?) ad. Sipi, Rio Sipi: 12.ix.08.—Wing 82; tail 71; bill 20½ mm.

No. 2467. ♂ (?) ad. Noanama: 13.i.09.—Wing 80; tail 69; bill 20 mm.

Nos. 2725, 2701. ♂ ♀ ad. Tadó: 8, 28.vi.09.—Wing 87, 86; tail 70; bill 21, 22 mm.

No. 2093. ♀ ad. Sipi: 19.ix.08.—Wing 83; tail 67; bill 20 mm.

“Iris dark brown, feet greyish green or black brown, maxilla black, mandible light brown.”

This series agrees perfectly with two specimens from Western Ecuador (Carondelet, Paramba) in the Munich Museum. The upper part of the head is nearly uniform olive-brown with obsolete dusky edges to the feathers; the back wholly unstriped, rufescent brown; the upper wing-coverts and outer webs of the remiges are deep russet-brown; the breast and abdomen dull light olivaceous, the chest but indistinctly mottled with buffy, etc. etc.

The Costa Rica form, *H. s. virgatus* Lawr.*, may be distinguished from *H. s. assimilis* by its more elongated as well as slenderer bill ($23\frac{1}{2}$ to 24 mm.); bright chestnut-brown colour of the wing-coverts and remiges; blackish ground-colour of the pileum and nape, with sharply defined, buff shaft-streaks; by having the upper back distinctly streaked with buff, etc.

Mr. Ridgway has rightly separated *P. virgatus* under the new generic term *Hylocistis* †, but it is certainly only subspecifically distinct from *H. s. subulatus* and *H. s. assimilis*, the three races replacing each other geographically. With regard to the differences between the two last-named races see my remarks in Nov. Zool. xvii. 1910, p. 320.

108. XENICOPSIS SUBALARIS SUBALARIS Scl.

Anabates subalaris Scater, P. Z. S. 1859, p. 141 (1859.—Pallatanga, W. Ecuador).

Anabazenops subalaris Scater, Cat. B. Brit. Mus. xv. p. 108 (part.: a-c, Pallatanga; d, Quito).

No. —. ♂ ad. Loma Hermosa, R. Jamaraya, 4150 ft., 19.x.09.—Wing 91; tail 84; bill 19 mm.

“Iris dark grey, feet grey-green, maxilla black, mandible yellow.”

This bird is somewhat difficult to place. In coloration, notably in the dark brown ground-colour of the pileum and back, it agrees with topotypical West Ecuadorian specimens; but it is fully as large as the Central American form, *X. s. lineatus* Lawr. ‡, which, however, has the head above and the back of a distinctly paler, more olivaceous brown tinge. Until more specimens from Western Colombia come to hand its identification can be regarded only as provisional.

X. s. subalaris inhabits the elevated districts of the Western Cordillera in Ecuador and Colombia, extending down the slope to about 2000 feet.

X. mentalis Tacz. & Berl. §, united by Dr. Scater to *X. s. subalaris*, is a very distinct species, though it may eventually prove to be the Eastern representative. It differs particularly in the following characters: the top of the head is much darker, blackish, and covered with broad, buff shaft-stripes, while in *X. s. subalaris* there are but a few narrow hair-like streaks to be seen; the upper back also shows much broader as well as more numerous buff stripes; the whole under surface, posterior to foreneck, is likewise broadly striped all over with yellowish

* *Philydor virgatus* Lawrence, Ann. Lyc. N. H. N.Y. viii. p. 468 (1867.—Angostura, Costa Rica).

† Proc. Biol. Soc. Wash. xxii. p. 72 (1909.—Type: *Philydor virgatus* Lawr.).

‡ *Anabazenops lineatus* Lawrence, Ann. Lyc. N. H. N.Y. viii. p. 127 (1865.—Angostura, Costa Rica).

§ *Anabazenops mentalis* Taczanowski & Berlepsch, P. Z. S. 1885, p. 96 (1885.—Machay, Eastern Ecuador).

white, etc., etc. The pattern of the upper parts reminds one rather of *Automolus holostictus* ScL & Salv., yet it need not be emphasized that this species is generically distinct.

Of *X. mentalis*, I have examined two adult males and an immature female from Machay, E. Ecuador, and two Bogotá skins, one in the British Museum, the other in Count Berlepsch's collection.

109. *XENOPS GENIBARBIS LITTORALIS* ScL.

[*Xenops genibarbis* Illiger, Prodr. Syst. Mamm. et Av. p. 213 (1811.—Cametá, Lower Amazons).]

Xenops littoralis Selater, P. Z. S. 1861, p. 379 (1861.—Esmeraldas, N.W. Ecuador).

Xenops ruficauda (nec Vieillot) Cassin, Proc. Ac. N. Sci. Philad. 1860, p. 193 (Turbo, N. Colombia).

Xenops genibarbis (nec Illiger) Selater & Salvin, P. Z. S. 1879, p. 523 (Remedios).

No. 2039. ♂ imm. Noanama: 31.viii.08.—Wing 61; tail 46; bill $12\frac{1}{2}$ mm.

No. 2479. ♀ ad. Noanama: 15.i.09.—Wing 61; tail $46\frac{1}{2}$; bill 13 mm.

No. 2646. ♂ ad. Tadó, R. San Juan: 17.v.09.—Wing $62\frac{1}{2}$; tail 48; bill 13 mm.

"Iris dark brown, feet blue-grey, bill black."

These birds agree with topotypical examples from the Ecuadorian province of Esmeraldas. *X. g. mexicanus* ScL.*, which ranges from E. Mexico to Panama, is more rufescent, less olive, underneath, and has the back of a brighter, clearer cinnamonous-brown.

X. g. littoralis inhabits the lowlands and foothills of Western Ecuador and Western Colombia.

110. *GLYPHORHYNCHUS CUNEATUS CASTELNAUDII* Des Murs.

[*Dendrocolaptes cuneatus* Lichtenstein, Abhandl. Akad. Berlin a. d. Jahren 1818-19, p. 204, pl. ii. fig. 2 (1820—"in Brasilie provincia Bahia"; cfr. idem, l. c. a. d. Jahren 1820-21, p. 264).]

Glyphorhynchus castelnaudii Des Murs, in Castelnau's Voyage, Oiseaux, p. 47, pl. xv. fig. 2 (1856.—Santa Maria, Eastern Peru).

Glyphorhynchus cuneatus (errore) Selater & Salvin, P. Z. S. 1879, p. 523 (Remedios).

Nos. 2019, 2177. ♂ imm., ♀ ad. Sipi: 10.x.; Noanama: 26.viii.08.—Wing 69, 67; tail 70, 62; bill 12 mm.

"Iris dark brown, feet dark grey, maxilla black, mandible grey."

Slightly smaller than Upper Amazonian skins, but similar in coloration.

* *Xenops mexicanus* Selater, P. Z. S. 1856, p. 289 (Jan. 1857.—Cordova, E. Mexico).

111. *DENDRORNIS LACHRYMOSA ROSTRATA* Ridgw.

[*Dendrornis lachrymosus* Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 467 (1862.—Panama).]

Xiphorhynchus lachrymosus rostratus Ridgway, Proc. Biol. Soc. Wash. xxii. p. 73 (1909.—Rio Dagua, "North-western" Colombia).

Dendrornis lachrymosa (errore) Selater & Salvin, P. Z. S. 1879, p. 523 (Remedios); Hartert, Nov. Zool. ix. 1902, p. 616 (N.W. Ecuador).

Dendrornis — sp. Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 194 (R. Truando).

Nos. 2587, 2615. ♂ ♂ ad. Condoto, R. Condoto, 150 ft.: 6.20.iv.09.—Wing 126, 122; tail 103, 98; bill 37 mm.

Nos. 2004, 2005. ♂ imm., ♀ imm. Noanama, 100 ft.: 24.26.viii.08.—Wing 126, 120; tail 105, 102; bill 35, 32 mm.

"Iris dark brown, feet green, maxilla black, mandible grey."

These specimens, as well as several others from North-western Ecuador (Bulún, Carondelet), have the bill slightly deeper and stouter than typical birds from Panama. The culmen, however, is not more strongly arched. I must confess I am not very confident as to the distinctness of this race and should not be surprised if a larger series would show it to be inseparable from *D. l. lachrymosa*. *D. l. rostrata*, if really distinguishable, ranges from N.W. Colombia (Rio Truando) along the Pacific coast southwards to the north-western portion of Ecuador. It is found only in the lowlands and on the hill-slopes.

112. *DENDRORNIS TRIANGULARIS ÆQUATORIALIS* Berl. & Tacz.

[*Dendrocolaptes triangularis* Lafresnaye, Rev. Zool. v. p. 134 (1842.—"Boliviâ,"* errore; the type came from Santa-Fé-de-Bogotá, Colombia).]

Dendrornis erythropygia æquatorialis Berlepsch & Taczanowski, P. Z. S. 1883, p. 563 (1883.—Chimbo, W. Ecuador); Hartert, Nov. Zool. v. 1898, p. 490 (Chimbo, Paramba, W. Ecuador).

D. æquatorialis Salvadori & Festa, Boll. Mus. Torino, xiv. no. 362, 1899, p. 25 (R. Peripa, W. Ecuador).

D. punctigula (errore) Goodfellow, Ibis, 1902, p. 63 (Nanegal, Intac, Gualea, W. Ecuador; specimens examined).

No. 2378. ♂ ad. Nóvita: 7.xii.08.—Wing 117; tail 103; bill 34 mm.

* The locality "Bolivia" is certainly a mistake, for in Mag. Zool. 1843, Oiseaux, pl. 32, Lafresnaye expressly says: "vient de Santa-Fé-de-Bogotá." This statement is repeated in Rev. Mag. Zool. (2) ii. 1850, p. 419, in the French text, while the Latin diagnosis (a *verbatim* reprint of the original account) terminates with the indication: "habitat in Boliviâ." Moreover, at that time, Bogotá skins reached Paris in large numbers, whereas material from Bolivia was very scarce in European Museums. In fact, D'Orbigny was the only naturalist to send collections from that country, but he did not obtain the species in question.

No. 2529. ♂ ad. El Tigre, 320 ft.: 10.ii.09.—Wing 116; tail 103; bill 34 mm.

"Iris dark brown, feet grey-green or blue, maxilla black, tip light brown, mandible grey."

The two skins agree perfectly with a series from Western Ecuador in the Munich Museum. *D. t. æquatorialis* is an excellent form, differing in many important details from the typical race of Central Colombia, W. Venezuela, etc. The rump and the wings are much darker chestnut rufous; the ground-colour of the throat is decidedly buff, instead of whitish; the dark olive markings on the throat are restricted to small, rounded apical spots, while in the allied *D. t. triangularis* the feathers show a continuous, marginal edge, giving a squamate appearance; the top of the head is wholly unstreaked, plain dark olive, only sometimes with a few buff shaft-lines on the forehead, whereas the typical form has the entire crown conspicuously streaked or spotted with pale buff, etc.

D. t. punctigula Ridgw. * from Costa Rica and Chiriqui, is most closely related to *D. t. æquatorialis*, agreeing in the pattern of the throat and in the uniform pileum, but differs in the clearer rufous rump and wings, the deeper olive-green ground-colour, and the smaller, less rounded spots of the lower parts. Single examples are, however, not always distinguishable.

D. t. triangularis shows a distinct, whitish lateral stripe near the lower edge of the maxilla, while in *D. t. æquatorialis* and *D. t. punctigula* the upper bill is uniform dark horn-brown or blackish. This difference is quite constant in the enormous series which I have examined.

D. t. æquatorialis is strictly confined to the western slopes of the Andes in Ecuador and Southern Colombia. In Ecuador it ranges from sea-level up to about 3500 feet, for we have specimens from Ventana (90 feet) and Bulón (160 feet) as well as from Lita (3200 feet) and Paramba (3500 feet). From Colombia, west of the Coast Cordillera, I have seen only Palmer's two skins, one taken at 150, the other at 320 feet elevation †.

D. t. triangularis inhabits the Central and Eastern Cordillera of Colombia, the mountains of Western Venezuela (Merida, Cumbre de Valencia), the eastern slopes of the Ecuadorian Andes, and Northern Peru. Two specimens from the Cauca slope of the Coast Cordillera—one, from Santa Elena, in the British Museum, the other, from Riollima, at Tring—also belong to this form, being in every respect typical. Birds from Eastern Ecuador (Machay,

* *Dendrornis punctigula* Ridgway, Proc. U.S. Mus. xi. p. 544 (1889.—Naranjo, Costa Rica).

† My material of *D. t. æquatorialis* consisted of the following specimens:—6 from Chimbo, including the type (Mus. H. v. Berlepsch & Tring); 2 from Cachabi (Tring); 7 Paramba, 6 Lita, 1 Ventana, 5 Bulón (Mus. Tring, Munich, Vienna, etc.); 3 Nanegal, 2 Nono, 1 Intag (Goodfellow coll.—Tring), 2 Chocó, W. Colombia (Munich): 35 examples in all.

Baeza *) and North Peru (Chachapoyas) are absolutely identical with those from Bogotá and Venezuela †.

On a future occasion I hope to give some information respecting several other species of the genus *Dendroornis* which, through lack of proper material, are very imperfectly known.

113. *DENDROCINCLA MERULOIDES LAFRESNAYEI* Ridgw.

[*Dendrocops meruloides* Lafresnaye, Rev. Mag. Zool. (2) iii. p. 467 (1851.—“Côte ferme,” sc. Cumaná, Venezuela).]

Dendrocinclafresnayei Ridgway, Proc. U. S. Mus. x. 1887, p. 492 (1888.—“Upper Amazons?”—errore; we substitute Colombia as type locality).

D. olivacea lafresnayei Oberholser, Proc. Acad. N. Sci. Philad. 1904, p. 457 (crit.).

No. 2460. ♀ (?) ad. Noanama: 11.i.09.—Wing 102; tail 88; bill 26 mm.

No. 2113. ♀ imm. Sipi: 23.ix.08.—Wing 95; tail 81; bill 25 mm.

“Iris dark brown, feet and bill black.”

These specimens agree well with others from Western Ecuador, and Riolima, Cauca Valley. Bogotá skins are slightly more rufescent both above and below, thus pointing towards *D. l. phaeochroa* Berl. & Hart.

D. m. lafresnayei ‡, *D. m. phaeochroa*, and *D. m. meruloides* are clearly races of one and the same species, representing each other geographically. The first-named form may always readily be distinguished from the two others in having the outer webs of the quills conspicuously washed with olivaceous, and the dusky portions of the bill much darker, black instead of horn-coloured. On the other hand, *D. m. meruloides* differs from *D. m. phaeochroa* in its much brighter, more cinnamon or ochraceous-brown coloration.

Range and principal synonyms of these forms are as follows:—

(a) *D. MERULOIDES MERULOIDES* Lafr.

Dendrocops meruloides Lafresnaye, Rev. Mag. Zool. (2) iii. p. 467 [1851.—“Côte ferme,” sc. Cumaná; cfr. Ménégau & Hellmayr, Mém. Soc. Hist. Nat. Autun, xix. 1906, p. 121 (crit.).]

Dendrocinclameruloides Cabanis & Heine, Mus. Hein. ii. 1859, p. 34 (Caraccas); Sclater & Salvin, P. Z. S. 1868, p. 167 (Pilar, Venezuela); Chapman, Bull. Amer. Mus. N. Y. vi. 1894, p. 48 (Trinidad); Berlepsch & Hartert, Nov. Zool. ix. 1902, p. 67

* *D. erythropygia* (!) Goodfellow, Ibis, 1902, p. 63 (Baeza, E. Ecuador).

† My material of *D. t. triangularis* was composed as follows:—9 Bogotá (Tring, Munich, H. & B.), 1 Santa Elena, 1 Riolima, Cauca (Brit. Mus., Tring), 10 Merida (Tring & Munich), 3 Cumbre de Valencia (Munich), 4 East Ecuador (2 Machay, H. & B.; 2 Baeza, Tring), 2 N. Peru, Chachapoyas (Tring): 30 examples in all.

‡ = *D. olivacea* auct. ex parte: America merid.

(Cumaná, San Esteban); Hellmayr, Nov. Zool. xiii. 1906, p. 29 (Trinidad).

D. meruloides aphantia Oberholser, Proc. Acad. N. Sci. Philad. 1904, p. 460 (Tobago).

Type locality: Cumaná, Venezuela.

Hab. Tobago; Trinidad; North Coast of Venezuela: from Cumaná to Puerto Cabello.

Examined: 16 Trinidad, 2 Tobago, 6 Cumaná, 1 Caraccas, 12 San Esteban (near Puerto Cabello).

(b) *D. MERULOIDES PHÆOCHROA* Berl. & Hart.

*Dendrocincla** *phaeochroa* Berlepsch & Hartert, Nov. Zool. ix. p. 67 (1902.—Munduapo (type), Maipures, Nericagua, Orinoco; Suapure, La Pricion, Caura R.); Ihering, Rev. Mus. Paul. vi. 1905, p. 437 (Rio Jurúa); Snethlage, Journ. f. Orn. 1908, p. 15 (Rio Purús).

D. olivacea phaeochroa Oberholser, Proc. Acad. N. Sci. Philad. 1904, p. 458 (Suapure, La Union, Caura).

D. fumigata (errore) Pelzeln, Zur Orn. Bras. i. 1867, p. 42 (part. Rio Branco, spec. examined); Taczanowski, P. Z. S. 1882, p. 27; idem, Orn. Pérou, ii. 1884, p. 168 (Huambo, N. Peru).

D. olivacea (nec Lawrence) Sclater, Cat. B. xv. p. 166 (part.: *l, m*, Sarayacu, E. Ecuador; *n*, Rio Napo; *q*, Iquitos, N. Peru; spec. examined).

Dendrocolaptes atrirostris (nec Lafr. & D'Orb.) Sclater, P. Z. S. 1858, p. 63 (Rio Napo; spec. examined).

Type locality: Munduapo, Orinoco R.

Hab. Amazonian region: from the Rio Branco, N. Brazil, and the Caura Valley, Eastern Venezuela, westwards to N. Peru and the eastern slopes of the Colombian and Ecuadorian Andes.

Examined: 7 Munduapo (incl. type), 2 Maipures, 2 Nericagua, 6 Caura, 1 Rio Branco, 1 R. Jurúa, 2 N. Peru (Iquitos, R. Tigre), 3 Rio Napo, E. Ecuador, 3 Bogotá.

(c) *D. MERULOIDES LAFRESNAYEI* Ridgw.

D. lafresnayeri Ridgway, Proc. U.S. Mus. x. 1887, p. 492 (1888.—"Upper Amazons," errore).

D. olivacea lafresnayeri Allen, Bull. Amer. Mus. xiii. 1900, p. 156 (Santa Marta); Oberholser, Proc. Acad. N. Sci. Philad. 1904, p. 457 (crit.).

Dendrocops atrirostris (errore) Sclater, P. Z. S. 1860, p. 66 (Pallatanga, W. Ecuador); idem, l. c. p. 278 (Babahoyo); idem, l. c. p. 293 (Esmeraldas).

Dendrocincla atrirostris Taczanowski, P. Z. S. 1877, p. 332 (Palma, S.W. Ecuador); Berlepsch & Taczanowski, P. Z. S. 1883, p. 563 (Chimbo, S.W. Ecuador).

D. olivacea Sclater, Cat. B. Brit. Mus. xv. p. 166 (part.: Colombia (Bogotá, Manaure), W. Ecuador); Hartert, Nov. Zool.

* Spelt *Dendrocinda*.

v. 1898, p. 491 (Paramba, N.W. Ecuador); Goodfellow, Ibis, 1902, p. 63 (Sto. Domingo, W. Ecuador); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 27 (Vinces, W. Ecuador).

D. o. anguina Bangs, Proc. Biol. Soc. Wash. xx. p. 138 (1898.—Santa Marta); idem, l.c. xiii. 1899, p. 100 (Sierra Nevada de Santa Marta).

Hab. Colombia (Bogotá, Santa Marta, Riolima, Chocó, etc.) and Western Ecuador (Paramba, S. Javier, Esmeraldas, Pallatanga, Babahoyo, Vincés, Chimbo, Santo Domingo, Palmar, etc.), from sea-level up to 6000 feet.

Examined: 15 Western Ecuador, 1 Santa Marta (Manaure), 1 Riolima, Cauca, 2 Chocó, 5 Bogotá.

N.B.—The original locality "Upper Amazons" is doubtless erroneous, the species being strictly confined to the western slopes of the Andes. In the Amazonian district it is replaced by the preceding form.

114. CYMBILANIUS LINEATUS FASCIATUS Ridgw.

[*Lanius lineatus* Leach, Zool. Misc. i. p. 20, pl. vi. (1814.—Berbice, British Guiana).]

Cymbilanius lineatus fasciatus Ridgway, Proc. U.S. Mus. vi. 1883, p. 415 (1884.—Rio Sucio, Costa Rica).

C. lineatus (nec Leach) Selater & Salvin, P.Z.S. 1879, p. 524 (Remedios, Neche).

No. 2571. ♂ imm. Condoto: 27.iii.09.—Wing 72; tail 69; bill 21 mm.

No. 2572. ♀ ad. Condoto: 27.iii.09.—Wing 72; tail 68; bill 21 mm.

"Iris red-brown, feet blue-grey, maxilla black, mandible grey."

Specimens from W. Colombia and W. Ecuador have the black barring of the lower parts slightly broader than those from Cayenne and Amazonia. Although topotypical Costa Rican birds are not available for comparison, I think they belong to Ridgway's subspecies.

C. l. fasciatus is confined to the lowlands and foot-hills.

115. THAMNOPHILUS MAJOR TRANSANDEANUS Sel.

[*Thamnophilus major* Vieillot, Nouv. Dict. iii. p. 313 (1816.—ex Azara: Paraguay).]

T. transandeanus Selater, P. Z. S. 1855, p. 18 (1855.—Guayaquil, S.W. Ecuador); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 188 (Türbo).

No. 1972. ♂ ad. Guineo, Rio Calima, 6.viii.08.—Wing 92; tail 70; bill 27 mm.

No. 2528. ♀ ad. El Tigre, R. Tamaná, 320 ft., 10.ii.09.—Wing 91; tail 69; bill 27 mm.

No. 3777. ♂ ad. La Selva, R. Jamaraya, 4600 ft., 1.x.09.—Wing 94; tail 70; bill 28 mm.

"Iris vermilion, feet blue, bill black."

The Tring Museum possesses an adult male obtained by Mr. Rosenberg at Rio Dagua (Juntas), May 27, 1895. The males from W. Colombia agree, in coloration and size, with a series from Western Ecuador and Chiriqui, the under tail-coverts being black with distinct white apical margins.

T. m. transandeanus is, otherwise, known only as an inhabitant of the lowlands (from sea-level up to 1000 feet), and its occurrence at La Selva (4600 feet alt.) must be regarded as exceptional.

In the Central and Eastern Cordilleras it is replaced by a nearly allied, but easily recognizable race, *T. m. granadensis* Cab.*, which forms the passage to *T. m. melanurus* Gould, of Upper Amazonia. It differs, in the male sex, from *T. m. transandeanus* in having the under tail-coverts cinereous with a white apical edge preceded by a distinct blackish subterminal band, and in its much slenderer, weaker bill. I have examined several Bogotá skins in the collections of the Paris and Munich Museums, an adult male from Antioquia (Salmon)†, and one from near Mérida (Briceño) at Paris, and four males from N.W. Venezuela (♂ ad., ♂ imm., Mt. Bucarito, Tocuyo; ♂ ad. Ejido, near Mérida; ♂ ad. San Estebán—Mocquerys coll.) in the Tring Museum. All of them very clearly show the characters indicated above. Cf. also Ménégau & Hellmayr, Bull. Soc. Philom. Paris (9) viii. 1906, pp. 25–26.

116. *THAMNOPHILUS NÆVIUS* ATRINUCHA Salv. & Godm.

[*Lanius nævius* Gmelin, Syst. Nat. 1, i. p. 308 (1788—ex Latham : Cayenne).]

Thamnophilus atrinucha Salvin & Godman, Biol. Centr.-Amer., Aves, ii. p. 200 (1892.—“Central America,” no type specified; we fix Panama as terra typica).

T. nævius (nec Gmelin) Sclater & Salvin, P. Z. S. 1879, p. 524 (Neche, Antioquia); Berlepsch, Journ. f. Orn. 1884, p. 307 (Bucaramanga); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 188 (Turbo).

No. 1967. ♂ imm. San Joaquim : 4.viii.08.—Wing 71; tail 61; bill $18\frac{1}{2}$ mm.

No. 2049. ♂ imm. Noanama : 2.ix.08.—Wing 70; tail 56; bill 18 mm.

No. 2127. ♂ ad. Sipi : 28.ix.08.—Wing 70; tail 54; bill $18\frac{1}{2}$ mm.

Nos. 2411, 2425, 2435. ♂ ♂ ad. Nóvita : 18, 22, 24.xii.08.—Wing 70–74; tail 56–59; bill $18\frac{1}{2}$ mm.

Nos. 2395, 2428, 2431, 2436. ♀ ♀. Nóvita : 12, 23, 24, 26.xii.08.—Wing 68–69; tail 54–58; bill 17– $18\frac{1}{2}$ mm.

“Iris brown or red-brown in male, grey in female, feet blue or blue-grey, maxilla black, mandible grey.”

Specimens from Colombia and Western Ecuador are practically

* *Diallactes granadensis* Cabanis, Journ. f. Orn. 1872, p. 234 (Bogotá coll.).

† *T. transandeanus* (errore) Sclater & Salvin, P. Z. S. 1879, p. 524 (Remedios, Neche : Antioquia).

identical with others from Costa Rica. *T. n. atrinucha* replaces *T. n. naevius* on the western sides of the Andes, while the typical form is found in the Guianas, the Orinoco Valley and its tributaries.

For the distinguishing characters and geographical distribution of the various races of this group see my remarks in Abhandl. Bayer. Akad. Wissensch. II. Cl., vol. xxii. 3, 1906, p. 658 ff.

117. MYRMOTHERULA SURINAMENSIS PACIFICA, subsp. n.

No. 2132. ♂ ad. Sipi : 30.ix.08.—Wing 53 ; tail 30 ; bill 16 mm.

Nos. 1974, 2133. ♀ ♀ ad. Guineo, R. Calima : 6.viii.08 ; Sipi : 30.ix.08.—Wing 52, 50 ; tail 30 ; bill $14\frac{1}{2}$, 15 mm.

[No. 09.788. ♂ ad. Buenaventura, 23.iii.99.—Wing $52\frac{1}{2}$; tail 29 ; bill 15 mm.

No. 09.787. ♂ ad. Plano de los Monos, near Naranjo, 2800 ft., 3.iv.99.—Wing 53 ; tail $31\frac{1}{2}$; bill 15 mm.

No. 09.789-791. ♀ ♀ ad. Buenaventura : 11, 18, 23.iii.99.—Wing 51-52 ; tail 28-30 ; bill $14\frac{1}{2}$ -15 mm.

These five specimens were collected by Eugène André.]

“ Iris dark brown, feet blue-grey, bill black, mandible grey.”

Adult. Differs from *M. s. surinamensis* Gm., in its longer tail, much stronger as well as decidedly longer bill, wider white tips to the outer rectrices (about 3 to 4 mm. on outermost pair), and in having the upper back less variegated with black, while the white interscapular blotch is much smaller in the male and wholly absent in the female. The latter sex, too, has the top of the head conspicuously clearer, about “tawny ochraceous” (Ridgw. Nomencl. v. fig. 4) instead of “deep tawny” (l. c. v. fig. 1), and the dark stripes on the hind crown and nape are much duller and less pronounced, being pale dusky olive instead of deep black.

Type in the Zoological Museum, Munich : no. 09.789. ♀ ad. Buenaventura, Chocó, W. Colombia, March 11, 1899. E. André coll.

Besides the above, I have examined in the Tring Museum three males and three females obtained at Juntas, Rio Dagua, by Messrs. Rosenberg and Raap, and in the British Museum a single female from Remedios, collected by T. K. Salmon. Dr. Hartert* has already alluded to this form, and, after studying large series from various localities, I have no hesitation in separating the Pacific birds from true *M. s. surinamensis*. The typical race is confined to Surinam, French and British Guiana, extending westwards to the Caura Valley, Eastern Venezuela, while *M. s. pacifica* ranges from Western Ecuador through Colombia north to Veragua. The females of both forms have the sides of the head, the foreneck and chest uniform ochraceous, thereby differing very conspicuously from the Amazonian race *M. s. multostriata* ScL†.

* Nov. Zool. ix. 1902, p. 612.

† Cfr. Hellmayr, Nov. Zool. xvii. 1910, p. 345.

Characters and range of the two races are as follows:—

(a) *M. SURINAMENSIS SURINAMENSIS* Gm.

Sitta surinamensis Gmelin, Syst. Nat. 1, i. p. 442 (1788—based on: “Surinam Nuthatch,” Latham, Gen. Syn. 1, ii. p. 654, pl. 28 (= ♀): Surinam).

Formicivora quadrivittata (ex Lichtenstein MS.) Cabanis, Arch. f. Naturg. 13, i. p. 227 [1847.—Guiana (Schomburgk)].

Myrmotherula surinamensis Scater, Cat. B. Brit. Mus. xv. p. 231 (part.: *m-g*, Brit. Guiana; *v*, Cayenne); Salvin, Ibis, 1885, p. 425 (Camacusa); Berlepsch & Hartert, Nov. Zool. ix. 1902, p. 73 (Caura); Berlepsch, Nov. Zool. xv. p. 154 (Cayenne).

Adult. Bill short and slender; white tips to external rectrices restricted, not more than $1\frac{1}{2}$ to 3 mm. wide on outermost pair. Upper back, in both sexes, mostly black, variegated with narrow white edges, base of feathers extensively white, forming a large, concealed dorsal patch. Female with upper part of the head deep tawny, crown and nape broadly streaked with deep black; sides of the head, throat, foreneck and chest bright ochraceous, middle of throat sometimes paler, ochraceous-buff or buff; rest of lower parts buff, flanks shaded with greyish. On the sides of the neck and chest there are sometimes a few faint dusky shaft-lines, but in most specimens these parts are quite uniform.

Hab. Surinam: Paramaribo (*Chunkoo*: Tring Museum); French Guiana: Approuague, Ipousin (*Cherrie*: Tring Museum), Saint-Jean-du Maroni (*Le Mout*: Munich Mus.); British Guiana: Camacusa, Takutu R., Carimang R. (*Whitely*). East Venezuela, Caura Valley: Nicare, La Pricion, Suapuré, Mato R. (*André, Klages*: Tring and Munich Mus.)*.

Material. 22 specimens. Birds from various localities measure as follows:—

Two ♂♂ ad. Camacusa, British Guiana.—Wing 50, 52; tail 25, 26; bill 14, 15 mm.

Two ♂♂ ad. Paramaribo, Surinam.—Wing 50, 52; tail 25, 25½; bill 14 mm.

Three ♂♂ ad. French Guiana.—Wing 49–51; tail 24–25; bill 14–15 mm.

Five ♂♂ ad. Caura R., Venezuela.—Wing 52; tail 25–27; bill 14–15 mm.

Two ♀♀ ad. Surinam.—Wing 49; tail 24½–25; bill 14 mm.

One ♀ ad. Carimang R., British Guiana.—Wing 50½; tail 26; bill 14½ mm.

Two ♀♀ ad. French Guiana.—Wing 49, 50; tail 24, 25; bill 14 mm.

Five ♀♀ ad. Caura R., Venezuela.—Wing 49–50; tail 25–27; bill 14½–15 mm.

* It must remain doubtful, in the absence of females, whether the single male from Munduapo, Upper Orinoco (*cf.* Nov. Zool. ix. p. 73) is referable to *M. s. surinamensis* or to *M. s. multistriata*.

(b) *M. SURINAMENSIS PACIFICA* Hellm.

M. surinamensis (nec Gmelin) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 190 (R. Truando, N. Colombia); Lawrence, Ann. Lyc. N. H. N. Y. vii. 1861, p. 293 (Isthmus of Panama); Sclater & Salvin, P. Z. S. 1864, p. 356 (Lion Hill, Panama); Sclater & Salvin, P. Z. S. 1879, p. 525 (Remedios); Berlepsch & Taczanowski, P. Z. S. 1883, p. 564 (Chimbo, S.W. Ecuador); Sclater, Cat. B. Brit. Mus. xv. p. 231 (part.: *a-g, j, k, l*); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 29 (part.: Peripa, W. Ecuador); Hartert, Nov. Zool. ix. 1902, p. 612 (San Javier, Pambilár, N.W. Ecuador); Goodfellow, Ibis, 1902, p. 64 (S. Nicolas, Guala, W. Ecuador).

"*Mijrmotherula* —?" Sclater, P. Z. S. 1860, p. 294 (Esmeraldas, N.W. Ecuador).

Adult. Bill strong and heavy; white tips to external rectrices larger, varying from three to five millimetres in width on the outermost pair. Upper back, in the male, much less variegated with black, the white dorsal patch much less extended. Female with upper part of the head much lighter, tawny ochraceous, crown and hind neck with narrow, rather indistinct, dusky olive shaft-streaks; upper back mainly pale grey, rather sparingly spotted with black and edged with white, but without any trace of the white dorsal blotch. Sides of the head and lower parts exactly as in the female of *M. s. surinamensis*.

Hab. Western Ecuador: Peripa (*Festa*), Intac (*Buckley*), San Nicolas, Guala (*Goodfellow & Hamilton*), Chimbo (*Siemi-radzki*), Esmeraldas (*Fraser*), San Javier, Pambilár (*Flemming & Miketta*). Western Colombia: Buenaventura (*André*), Guineo, Sipi (*Palmer*); Juntas (*Rosenberg, Raap*), Naranjó (*André*), Remedios (*Salmon*), R. Truando (*Wood*). Isthmus of Panama: Lion Hill (*McLeannan*), San Pablo (*Salvin*), Veragua (*Arcé*). [Also in Bogotá coll.]

Material. 41 specimens. Birds from various localities average as follows:—

Eight ♂ ♂ ad. W. Ecuador.—Wing 51–53; tail 28–30; bill 16 mm.

Six ♂ ♂ ad. W. Colombia, Chocó district.—Wing 52½–54; tail 29–31½; bill 15½–16½ mm.

Two ♂ ♂ ad. Panama (Lion Hill).—Wing 51; tail 27, 28; bill 15½, 16 mm.

Thirteen ♀ ♀ ad. W. Ecuador.—Wing 49–52; tail 28–30½; bill 15–16 mm.

Eight ♀ ♀. W. Colombia, Chocó district.—Wing 50–52; tail 28–30½; bill 14½–16 mm.

One ♀. Remedios, N.W. Colombia.—Wing 52½; tail 30½; bill 15 mm.

Two ♀ ♀ ad. Bogotá.—Wing 52, 53; tail 30, 31; bill 15 mm.

One ♀ ad. Panama (Lion Hill).—Wing 50; tail 27½; bill 15 mm.

118. MYRMOTHERULA FULVIVENTRIS VIDUATA Hart.

[*Myrmotherula fulviventris* Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 468 (1862.—Panama).]

Myrmotherula viduata Hartert, Nov. Zool. v. p. 492 (1898.—Cachabi, N.W. Ecuador; ♀).

M. fulviventris viduata idem, l. c. ix. p. 612 (crit.).

M. ornata? Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 191 (Rio Truando).

"*M.* —?" Sclater, P. Z. S. 1860, p. 294 (Esmeraldas, N.W. Ecuador).

M. fulviventris (nec Lawrence) Sclater & Salvin, P. Z. S. 1879, p. 525 (Remedios, Antioquia); Wyatt, Ibis, 1871, p. 331 (Naranjo, near Bucaramanga); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 29 (Peripa, W. Ecuador).

No. 2512. ♂ ad. El Tigre, 4.ii.09.—Wing 53; tail 34; bill $14\frac{1}{2}$ mm.

No. 2426. ♂ juv. Nóvita, 22.xi.08.—Wing $51\frac{1}{2}$; tail 38; bill 14 mm.

No. 2471. ♀ ad. Noanama, 13.i.09.—Wing 53; tail 38; bill $14\frac{1}{2}$ mm.

"Iris dark brown, feet blackish, bill black, mandible grey."

These specimens as well as several Bogotá skins agree perfectly with a series from W. Ecuador, including the type, kindly forwarded by Dr. Hartert from the Tring Museum. *M. f. viduata* differs from typical *fulviventris* in having the upper parts decidedly more brownish or rufescent brown, this being especially noticeable on the crown and upper tail-coverts; the edges to the quills and rectrices are also more reddish, and the females have the belly of a darker fulvous colour. *M. f. fulviventris* is known to me from seven skins from Nicaragua (Rio Grande) and Eastern Costa Rica (Carrillo, Reventazón, Matina R.), but I have not yet seen any from the type locality.

M. f. viduata apparently ranges all over the Pacific lowlands, up to about 2000 feet altitude, from the Rio Truando in the north to the neighbourhood of Guayaquil, S.W. Ecuador, in the south. There is an adult male in the Tring Museum from Ana Maria (not far from Guayaquil), procured by Herr G. von Buchwald in December 1905.

119. MYRMOTHERULA AXILLARIS MELANA Scl.

[*Myrmothera axillaris* Vieillot, Nouv. Dict. xii. p. 113 (1817.—"Guyane").]

Formicivora melana Sclater, P. Z. S. 1857, p. 130 (Oct. 1857.—Bogotá).

Myrmotherula melana Sclater & Salvin, P. Z. S. 1879, p. 525 (Neche, Antioquia); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 191 (R. Truando).

No. 2416. ♂ ad. Nóvita: 19.xii.08.—Wing 53; tail 35; bill 14 mm.

"Iris brown, feet and bill black."

Agreeing with Bogotá skins.

120. MYRMOTHERULA SCHISTICOLOR SCHISTICOLOR Lawr.

Formicivora schisticolor Lawrence, Ann. Lyc. N. H. N. Y. viii. p. 173 (1865.—Turrialba, Costa Rica).

Myrmotherula schisticolor Hellmayr, Verhandl. zool.-bot. Ges. Wien, liii. 1903, p. 210 (crit.).

No. 3765. ♀. Siató, Rio Siató: 21.ix.08.—Wing 57; tail 39; bill 12 mm.

“Iris dark brown, feet plumbeous, bill black, mandible horn-coloured.”

This bird agrees well with females from Costa Rica (Rio Naranjo, Boruca), Chiriqui (Boquete), and Western Ecuador, except in being slightly more greyish, less brownish, on the upper parts. I have not seen male examples from W. Colombia, but several from W. Ecuador, which I have before me, I am unable to separate from typical Costa Rican skins.*

On the other hand, in the Sierra Nevada de Santa Marta, N. Colombia, and in the mountains of Northern Venezuela (Cumbre de Valencia, Cumaná), a well-marked geographical race, *M. schisticolor sanctæ-martæ* Allen †, takes its place. The male may be immediately recognized in having the black colour restricted to the throat and middle of the foreneck, while in *M. s. schisticolor* it extends over the breast down to the upper abdomen. The females are not always distinguishable, though as a rule those of *sanctæ-martæ* have the back of a purer olive-grey, without any brownish tinge. The Munich Museum possesses a good series of this rare form from the Cumbre de Valencia and the mountains of Cumaná, Venezuela. The two males from S. Esteban, Venezuela, in the British Museum, Goering coll.‡, are likewise referable to *M. s. sanctæ-martæ*.

121. FORMICIVORA QUIXENSIS CONSOBRINA ScL.

[*Thamnophilus quixensis* Cornalia, Vertebr. Syn. Osculati Coll. p. 12 (1849.—Quixos, Eastern Ecuador).]

Formicivora consobrina Slater, P. Z. S. 1860, p. 279 (1860.—Babahoyo, S.W. Ecuador); Slater & Salvin, P. Z. S. 1879, p. 525 (Pocune).

F. quixensis (nec Cornalia) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 190 (R. Truando).

No. 1963. ♂ ad. San Joaquim, Bahia del Chocó, 3.viii.08.—Wing 48; bill 12 mm.

No. 2142. ♂ ad. Sipi: 1.x.08.—Wing 48; tail 45; bill 13 mm.

* Carriker (Ann. Carnegie Mus. vi. nos 2-4, 1910, p. 609), following Mr. Ridgway's lead, calls the Costa-Rica form *M. menetriesi schisticolor*. As a matter of fact, however, the bird long known under the name *M. menetriesii* has nothing to do with *menetriesii* of D'Orbigny, as I have clearly demonstrated in the paper quoted above. *M. menetriesii*, D'Orb. belongs to quite a different section, being a close ally of *M. cinereiventris* ScL. & Salv. Cfr. Bull. Soc. Philom. Paris (9) viii. 1906, pp. 61-2; Nov. Zool. xiv. 1907, pp. 69-70.

† *M. sanctæ-martæ* Allen, Bull. Amer. Mus. xiii. p. 160 (1900.—Valparaiso, Santa Marta).

‡ *M. menetriesi* (errore) Slater, Cat. B. xv. p. 240 (part.; *b*¹, *c*¹).

Nos. 2277, 2327. ♂♂ ad. Nóvita: 13, 23.xi.08.—Wing 48, 49; tail 47, 46; bill $13\frac{1}{2}$ mm.

Nos. 2276, 2310. ♀♀ ad. Nóvita: 13, 19.xi.08.—Wing 48; tail 45; bill 13 mm.

No. 2143. ♀ juv. Sipi: 1.x.08—Wing 47; tail 47; bill 12 mm.

"Iris dark brown, feet and bill black."

The series agrees with specimens from Western Ecuador. One of the females (no. 2143) approaches *F. q. boucardi* Scl., from Central America, in the paleness of the under parts, yet it can easily be distinguished by its much smaller, narrower bill, and much longer white tips to the outer rectrices.

F. q. consobrina is peculiar to W. Ecuador and W. Colombia, where it inhabits the hot, forest-covered low country from sea-level up to about 1500 feet.

122. *RAMPHOCÆNUS CINEREIVENTRIS CINEREIVENTRIS* Scl.

Rhamphocœnus cinereiventris Sclater, P. Z. S. 1855, p. 76, pl. lxxxvii. (June 1855.—"Pasto," S. Colombia, Delattre coll.).

No. 2506. ♂ ad. Nóvita: 29.i.09.—Wing 53; tail 31; bill 18 mm.

No. 2102. ♀ ad. Sipi: 21.ix.08.—Wing 52; tail 32; bill 19 mm.

No. 1976. ♂ imm. Guineo, Rio Calima: 7.viii.08.—Wing 54; tail 35; bill 18 mm.

"Iris dark brown, feet blue, maxilla black, mandible grey."

In addition we have an adult male obtained by Mr. Eugène André at El Paillon, near Buenaventura, May 6, 1899.

The specimens from Western Colombia and fourteen others from various localities in Western Ecuador (Chimbo, S. Javier, Cachyjacu, Lita, Rio Verde) agree perfectly with Sclater's original description, having a very distinct, dusky brown postocular streak, and the under parts of a rather clear cinereous with whitish admixture along the middle line. The type-specimen is said to have been obtained at Pasto, S. Colombia, alt. 8000 feet, which is certainly erroneous. *R. c. cinereiventris* is exclusively restricted to the low country and slopes of the Western Cordillera between sea-level and about 3000 feet.

R. c. semitorquatus Lawr.*, of which I have examined a good series from Eastern Costa Rica (Carrillo) and Chiriqui (Boquete), may easily be distinguished in lacking the brown postocular stripe and in having the belly rather darker cinereous with very little, if any, whitish suffusion in the middle.

A third geographical race of this group inhabits Eastern Ecuador†. It resembles the Central American form in the absence of the dusky postocular streak, but the upper parts are darker and the sides of the head much deeper coloured. I do not,

* *Rhamphocœnus semitorquatus* Lawrence, Ann. Lyc. N. H. N.Y. vii. p. 469 (1862.—Panama).

† *R. cinereiventris* (nec Sclater, 1855) Sclater, Cat. B. Brit. Mus. xv. p. 262 (Sarayacu, East. Ecuador).

however, feel justified in bestowing a name upon this subspecies, having seen but a few skins in not very good condition.

123. *CERCOMACRA TYRANNINA RUFIVENTRIS* Lawr.

[*Pyriglena tyrannina* Scater, P. Z. S. 1855, p. 90, pl. xcviii. (1855.—Bogotá coll.).]

Disythanus (sic) *rufiventris* Lawrence, Ann. Lyc. N. H. N.Y. viii. p. 131 (1865.—New Granada, line of Panama Railroad—descr. ♂ juv.); *cfr.* Salvin, Ibis, 1874, p. 316.

Cercomacra crepera Bangs, Auk, xviii. p. 365 (1901.—Divala, Chiriqui).

No. 1997. ♂ ad. Boca de Calima, Rio San Juan, 18.viii.08.—Wing 67; tail 58; bill $16\frac{1}{2}$ mm.

No. 1981. ♀ imm. Guineo, R. Calima: 8.viii.08.—Wing 60; bill 16 mm.

No. 2387. ♀ ad. Nóvita: 10.xii.08.—Wing 59; bill $16\frac{1}{2}$ mm.

No. 2742. ♀ ad. Pueblo Rico, 5200 ft., 8.ix.08.—Wing 62; tail 67 (!); bill $16\frac{1}{2}$ mm.

“Iris dark brown, feet blue-grey, bill black, mandible horn-coloured in females.”

These birds strictly belong to the dark western form separated by Mr. Bangs as *C. crepera*. Mr. Carriker* has already alluded to the variability of its characters, basing his conclusions upon Costa Rica skins. On comparing the series in the Munich Museum, it becomes at once evident that two fairly marked races can be distinguished. Adult males from Guatemala, Costa Rica, Chiriqui, W. Colombia and N.W. Ecuador are, notwithstanding some individual variation, much darker, more slaty blackish, both on upper and lower parts than specimens from Bogotá (topotypes), the upper Orinoco, British Guiana, and North Brazil (Pará, Rio Negro). The females also are somewhat darker ferruginous underneath. The single male from Calima is slightly paler grey on the belly, but similar specimens I have seen from S.W. Costa Rica, while several from N.W. Ecuador (San Javier) in intensity of coloration are practically identical with topotypical Chiriqui-skins. Mr. Bangs (*l. c.* p. 366) refers the birds from Loma del Leon (= Lion Hill), Panama, to typical *tyrannina*. I doubt, however, the correctness of this view, since two males from Monte Oscuro, near Panama City, though not extreme examples of *crepera*, are certainly much nearer that form than to *tyrannina*. Therefore, it seems to me that Lawrence's term *rufiventris*, founded upon an immature male from Lion Hill, must take precedence over *crepera*.

According to my views, the range of the two subspecies would be as follows:—

(a) *C. tyrannina tyrannina* (east of the Andes): E. Colombia (Bogotá, Bucaramanga, etc.); Venezuela: Orinoco (Munduapo) and Caura Valley; British Guiana; Northern Brazil: Rio Negro down to Manaus; Obidos, north bank of Amazons; Pará district.

* Ann. Carnegie Mus. v, 1908, p. 8; *l. c.* vi, 2-4, 1910, p. 613.

(b) *C. tyrannina rufiventris* Lawr. Central America from Guatemala southwards, Western Colombia and Western Ecuador, south to Chimbo.

124. *CERCOMACRA NIGRICANS* Sel.

Cercomacra nigricans Selater, P. Z. S. 1858, p. 245 (Nov. 1858.—Santa Marta* (type) and Bogotá-coll., Colombia; descr. ♂ imm.); Selater & Salvin, P. Z. S. 1879, p. 526 (Remedios, Antioquia); Berlepsch, Journ. f. Orn. 1884, p. 308 (Bucaramanga).

Pyriglena maculicaudis Selater, op. cit. p. 247 (Nov. 1858.—"Trinidad," errore; descr. ♂ ad.).

No. 1989. ♂ ad. Mouth of Calima, Rio San Juan, 13.viii.08.—Wing 67; tail 67; bill 18 mm.

"Iris dark brown, feet blue, bill black."

This bird is in the "*maculicaudis*" plumage, viz. glossy black all over, with the campterium, a large dorsal patch, distinct edges to the wing-coverts, and long apical spots to the outer rectrices white, and agrees with other adult males from N.W. Ecuador, and several Bogotá skins. Berlepsch & Hartert have shown that *C. maculicaudis* and *C. nigricans* are merely different sexes of the same species, and the examination of a large series of sexed specimens has convinced me that this view is perfectly right. It should also be borne in mind that the supposed two species have exactly the same range, extending from the Isthmus of Panama south to Western Ecuador. Mr. Cherrie took three specimens at Altagracia, Orinoco, two of which, marked "♂" by the collector, are in the "*maculicaudis*" phase, while the third, sexed as "♀," is even greyer, both above and below, than the type of *nigricans*. The locality "Trinidad" given for *P. maculicaudis* is certainly erroneous. I have examined the type and found it practically identical with adult males from Panama and Bogotá. The preparation furnishes no clue as to its origin. The specimen appears to have been remade, though it looks somewhat like the skins imported from Northern Colombia (Baranquilla, Cartagena, etc.).

C. carbonaria Sel. & Salv.†, from the Upper Rio Branco in Northern Brazil, is quite distinct, although nearly allied. The male differs in having the upper parts sooty grey; the throat and breast much duller black, shading into sooty grey on the flanks; in the shorter white tips of the rectrices, as well as in having distinct, though narrow, white apical edges to the secondaries. The female, too, is quite different, having the throat white freckled with dusky, and the belly bright ochraceous with the middle line whitish. *C. carbonaria* also has a much narrower and somewhat shorter bill. So far it has been met with only by Natterer,

* Although not taken in recent years by any collector, *C. nigricans* may yet be found in the Santa Marta district, for there is a specimen from Calamar, lower Magdalena (August 5, 1898) in the collection of H.R.H. The Princess Therese of Bavaria.

† Nomencl. Av. Neotrop. p. 161 (1873.—Rio Branco, N. Brazil).

who obtained a large series at Forte do Joaquim, on the confines of British Guiana.

125. *CERCOMACRA BERLEPSCHI* Hart.

Pyriglena berlepschi Hartert, Bull. B. O. C. vii. p. xxix (1898.—Cachabi, N.W. Ecuador; = ♂ ad.).

Thamnophilus cachabiensis Hartert, l. c. p. xxix (1898.—Cachabi, N.W. Ecuador; = ♀).

Cercomacra berlepschi Hartert, Nov. Zool. ix. 1902, p. 612 (crit.).

No. 1958. ♂ ad. S. Joaquim, Bahia del Chocó, 1.viii.08.—Wing 68; tail 46; bill $19\frac{1}{2}$ mm.

No. 2089. ♂ ad. Near Sipí, 200 feet alt., 18.ix.08.—Wing 69; tail $47\frac{1}{2}$; bill 19 mm.

No. 1966. ♀ ad. S. Joaquim, 4.viii.08.—Wing 67; tail 43; bill 19 mm.

“Iris dark red, feet and bill black.”

The males are uniform deep black, with a large, concealed white interscapular patch. The female is rather duller black, the abdomen slate-blackish, and the feathers of the throat, fore-neck, middle of the breast, as well as the lesser and median upper wing-coverts, show very distinct, though sometimes slight, white apical spots or edges. Dr. Hartert has already pointed out that these two types of coloration, originally described as different species, were merely male and female of one and the same species. From the evidence at hand, there can be no doubt that this view is correct.

The specimens from Chocó agree in every respect with the series from N.W. Ecuador in the Tring Museum*. *C. berlepschi* is somewhat difficult to place. In general form it closely resembles some of the short-tailed species, e. g. *C. tyrannina*, but the tail is much shorter and slightly rounded instead of being graduated, the wing relatively longer, and the bill longer as well as heavier. Although it might some day be found necessary to create a new genus for its reception, it would be unwise to do so without a thorough study of all the related groups.

126. *HYPOCNEMIS NÆVIÓIDES* Lafr.

Conopophaga nævioides Lafresnaye, Rev. Zool. x. p. 69 (1847—no locality given; type in Mus. Acad. Philadelphia, coll. Delattre—we fix as type locality Panama whence the Derby Museum (Liverpool) possesses two specimens obtained by Delattre; *cf.* Sclater, P. Z. S. 1858, p. 254).

Hypocnemis nævioides Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 190 (Falls of the Truando).

* In this connection a misleading error may be corrected. Hartert (*l. c.*) gives the length of the wing for *P. berlepschi*, as 44 to 46 mm. However, five adult males from N.W. Ecuador, including the type, in the Tring Museum present the following dimensions; wing 67–68½; tail 43–47; bill 19–20 mm. The females (5) are slightly smaller; wing 64–68; tail 41–46; bill 18–19 mm.

No. 2603. ♂ ad. Condoto: 16.iv.09.—Wing 63; tail 38; bill 16 mm.

Nos. 2341, 2491. ♀ ♀ ad. N6vita: 26.xi.08, 25.i.09.—Wing 62, 61; tail 37, 34; bill 16 mm.

Nos. 1977, 1999. ♀ ♀ imm. Guineo: 7.viii; mouth of Calima: 18.viii.08.—Wing 64, 62; tail 37, 35; bill 16 mm.

"Iris brown, feet blue-grey, bill black, lower mandible of females grey."

These specimens as well as others from N.W. Ecuador (San Javier) agree perfectly with typical Panama examples. Skins from Miravelles, Costa Rica, have, as a rule, the wing a trifle larger, and have the back of a clearer, brighter chestnut, but these variations are so inconstant that it appears to me highly improbable that the northern form, *H. n. capnitis* Bangs* can be maintained. This view is shared by Mr. Carriker†, who collected a large series of this species in Costa Rica.

Birds from different localities measure as follows:—

Five adult males from Miravelles, Costa Rica: wing 66–67; tail 34–37 mm.

Two adult males from Panama: wing 65, 65½; tail 36, 37 mm.
One adult male from W. Colombia: wing 63; tail 38 mm.

Three adult males from N.W. Ecuador (S. Javier): wing 63–65; tail 35–37½ mm.

Four adult females from Miravelles, Costa Rica: wing 63–65; tail 33–36 mm.

Two adult females from W. Colombia: wing 62, 61; tail 37, 34 mm.

One adult female from N.W. Ecuador (S. Javier): wing 61; tail 36 mm.

Both Mr. Bangs and Mr. Carriker give "Pasto, Cauca valley, Colombia" as the type locality, but this is an obvious error. First of all, Lafresnaye does not say where his type came from, and secondly the occurrence of *H. navioides* in the vicinity of Pasto (which lies high up in the mountains at an elevation of nearly 8000 feet) is utterly impossible, the species being restricted to the humid, tropical lowlands, from sea-level to about 2000 feet. Delattre most probably obtained the type at Panama, whence there are two of his skins in the Derby Museum (see above).

127. MYRMELASTES IMMACULATUS IMMACULATUS Lafr.

Thamnophilus immaculatus Lafresnaye, Rev. Zool. viii. p. 340 (1845—"ad Bogotam," deser. ♂ ♀).

Myrmeciza berlepschi (nec Ridgway) Bangs, Proc. Biol. Soc. Wash. xxiii. p. 73 (Palmar, Pavas, La Maria, W. Colombia).

No. 2818. ♂ ad. Pueblo Rico, San Juan slopes, 28.x.09.—Wing 84; tail 77; bill 22 mm.

* Proc. Biol. Soc. Wash. xix. p. 107 (1906.—Miravelles, Costa Rica).

† Ann. Carnegie Mus. vi. 1910, p. 619.

[Tring Museum. ♀ ad. Primavera, Cordillera occidental, 1904. Raap coll. No. 390.—Wing 79; tail 79; bill 20 mm.]

Mr. Ridgway* has correctly pointed out the distinctness of *M. immaculatus*, from Bogotá, and *M. i. berlepschi* Ridgw., from Western Ecuador, though some of his conclusions prove to be not well-founded. First of all, *M. i. berlepschi* does not occur anywhere in Colombia, the specimens from Bogotá mentioned by Berlepsch & Taczanowski†, which were kindly forwarded to me by the Count, being clearly referable to true *M. immaculatus*. The female from Primavera, W. Colombia, is practically identical with several Bogotá skins in the Berlepsch Collection. In all these females the lower parts (except the blackish upper throat) are rufescent brown, mottled with dull smoky grey on the foreneck and in the middle of the breast, while there is only a narrow white stripe on the bend of the wing.

Sixteen females from Western Ecuador (Chimbo, Paramba, Lita, Guala, Bulín, etc.) have a much larger, heavier bill, the forehead is more scantily feathered, the bend of the wing shows a large white patch, and the lower parts are much brighter rufous brown. The chin as well as the sides of the head are blackish, exactly as in *M. immaculatus* from Colombia. Seventeen adult males from Western Ecuador also differ from the Colombian ones in their larger bill, more scantily feathered forehead, and in having much more white on the shoulders. The general plumage is *sometimes*, though not always, deeper black.

M. immaculatus zeledoni Ridgw.‡, lately united to the Colombian form by Mr. Carriker§, appears to me to be much more closely allied to *M. i. berlepschi*. In fact, on comparing three adult males and two females from Costa Rica (Cariblanco de Sarapiquí) with the large series from Ecuador, I find the differences not very pronounced. All that can be said is that the northern birds have the white shoulder-patch slightly smaller. The females otherwise agree with those from Ecuador. More material from Costa Rica may even show the two forms to be inseparable.

128. MYRMELASTES EXSUL MACULIFER Hellm.

[*Myrmeciza exsul* Scater, P. Z. S. 1858, p. 540 (1859.—Panama: Delattre).]

Myrmelastes exsul maculifer Hellmayr, Nov. Zool. xiii. p. 340 (1906.—Paramba, N. Ecuador).

Myrmeciza exsul (nec Scater) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 191, no. 98 (= ♂), 99 (= ♀) (Turbo); Scater & Salvin, P. Z. S. 1879, p. 526 (Rio Neche, Antioquia).

Myrmelastes cassini Ridgway, Proc. Biol. Soc. Wash. xxi. p. 194 (1908.—Turbo, N. Colombia).

* Proc. Biol. Soc. Wash. xxii. 1909, p. 74.

† P. Z. S. 1883, p. 565.

‡ *Myrmeciza zeledoni* Ridgway, Proc. Biol. Soc. Wash. xxii. p. 74 (1909.—Guayabo, E. Costa Rica).

§ Ann. Carnegie Mus. vi. 1910, pp. 618-9.

Nos. 2082, 2145, 2178. ♂♂ ad. Sipi: 12.ix, 2, 12.x.08.—Wing 67–69; tail $44\frac{1}{2}$ –47; bill 18 mm.

No. 2234. ♂ ad. Rio Cajón: 3.xi.08.—Wing 68; tail 45; bill 18 mm.

No. 2438. ♂ ad. Nóvita: 28.xii.08.—Wing 69; tail $43\frac{1}{2}$; bill 19 mm.

Nos. 2017, 2018, 2038. ♀♀. Noanama: 26, 31.viii.08.—Wing 63; tail 40– $42\frac{1}{2}$; bill $17\frac{1}{2}$ –18 mm.

Nos. 2179, 2353. ♀ ad., ♂ juv. Sipi: 12.x.08; Nóvita: 30.xi.08.—Wing 63, 66; tail 42, 44; bill 18, 19 mm.

“Iris dark red, feet grey, bill black.”

When discussing the status of this species and its northern limits I alluded to the paler, less rufescent brown coloration of the specimens from Neche, Northern Colombia, in the British Museum (*cf.* Nov. Zool. xiii. p. 342), and two years later Mr. Ridgway separated two similar skins from Turbo under the name of *M. cassini**. The present series, however, shows considerable variation in the colour of the back. Six of the specimens have the back of exactly the same deep rufous or vandyke-brown shade as a large series from N.W. Ecuador, while the four remaining ones are somewhat lighter, more mars-brown above, like the two examples from Neche, Antioquia. Two adult males and one female obtained by Mr. Rosenberg on the Rio Dagua in 1895, agree again with the types from Paramba.

Neither is there any constant difference in the coloration of the head and underparts. Four males—two from Paramba, one from Sipi, one from Nóvita—are decidedly slaty blackish, while the majority of the skins, both from W. Ecuador and from Chocó, have the chest and belly paler, slate-grey.

Therefore, I cannot admit *M. cassini* as a valid form unless the Turbo birds be distinguished by other characters than those given in the original description. In addition to the above ten specimens, the Munich Museum possesses seven males and four females from N.W. Ecuador; and I have examined ten more from W. Ecuador, three from the Rio Dagua, in the Tring Museum, and the couple from Neche in London.

M. e. maculifer, as understood by me, is another Pacific type, its range being limited to the forest districts of Western Ecuador and Colombia.

129. ANOPLOPS BICOLOR DAGUÆ Hellm.

[*Pithys bicolor* Lawrence, Ann. Lyc. N. H. N. Y. viii. p. 6 (May 1863.—Panama Railway).]

Gymnopithys bicolor daguæ Hellmayr, Bull. B. O. C. xvi. p. 83 (1906.—El Paillon near Buenaventura, Chocó, W. Colombia; type in Tring Mus.).

* Mr. Ridgway also mentions a female from Cascajal, Coclé (Panama), as belonging to this form. There must, however, be some mistake with regard to the locality, since three adult males from that place in the Tring Museum are clearly referable to *M. exsul exsul*. Heyde's localities are not always trustworthy, and, as he also got many specimens from Western Colombia (Nóvita etc.), an error in labelling the bird might have occurred.

No. 2336. ♂ ad. Nóvita: 25.xi.08.—Wing 78; tail 51; bill 20 mm.

Nos. 2564, 2565. ♂ ♀ ad. Juntas, R. Tamaná: 9.iii.09.—Wing 77, 76; tail 48, 49; bill 20, 19½ mm.

"Iris brown, feet blue-grey, maxilla black, mandible grey."

The specimens are topotypical. The female differs from the males in having the dark grey colour of the forehead and sides of occiput less extended and in lacking the blackish border to the white chest.

A. b. daguae is nearest to *A. b. bicolor*, from Panama, but may be easily distinguished by the much darker, deep vandyke (rufous) brown instead of light russet-brown colour of the upper parts, much darker rufous-brown flanks, larger, stronger bill, and by the presence of a distinct blackish border to the white chest in the male sex.

A. b. æquatorialis Hellm., from Western Ecuador, agrees with *A. b. daguae* in the dark coloration of the back and flanks, but the forehead and crown are bright cinnamon rufous, the sides of the occiput alone being dark cinereous, etc.

The various races of *A. bicolor* not having been properly understood hitherto, it is hoped that the subjoined key will aid ornithologists in identifying specimens of the group. *A. leucaspis* Scl. is a near ally of *A. bicolor* and very likely its Amazonian (eastern) representative; it differs, however, in having the cheeks, malar region, and anterior ear-coverts white (instead of black), and in the possession of a large, concealed, pale cinnamonaceous interscapular patch in the female sex.

Key to the species and subspecies.

1. Cheeks, malar region, and anterior ear-coverts white.
Female with a distinct, light cinnamonaceous interscapular blotch. [Nasal plumes and whole pileum bright ferruginous. Lores and narrow superciliary stripe black]..... *A. leucaspis*.
- Cheeks, malar region, and whole of the ear-coverts black. Female without a pale interscapular blotch..... 2.
2. Sides of the occiput dark cinereous, abruptly contrasted with colour of crown..... 3.
- Sides of the occiput concolor with crown, never cinereous. [White chest laterally not bordered by a blackish stripe]..... 5.
3. Forehead and a broad superciliary stripe dark cinereous like the sides of the occiput..... 4.
- Forehead and crown ferruginous, only sides of occiput dark cinereous..... *A. bicolor æquatorialis*.
4. Crown and back light russet-brown; sides of body mars-brown; bill smaller: 17–18½ mm..... *A. bicolor bicolor*.
- Crown and back deep vandyke or dark rufous brown; sides of body vandyke brown; bill larger: 19½–21 mm..... *A. bicolor daguae*.
5. Head above light russet-brown; back umber-brown or very slightly tinged with rufescent; sides of body light mars-brown..... *A. bicolor olivascens*.
- Head above bright ferruginous; back decidedly cinnamon-brown; sides of body rufescent or russet-brown..... *A. bicolor ruficeps*.

(1) ANOPILOPS LEUCASPIS ScL.

Myrmeciza leucaspis Sclater, P. Z. S. 1854, p. 253, pl. lxx. (1855.—Bogotá, Colombia (type); Chamicuros, East. Peru; Cobati, Rio Negro).

Pithys leucaspis Sclater & Salvin, P. Z. S. 1867, p. 576 (Cobati); iidem, l. c. p. 751; iidem, l. c. 1873, p. 276 (Xeberos, Chyavetas, E. Peru); Pelzeln, Zur Orn. Bras. ii. p. 89 (Barcellos, R. Içanna, R. Uaupés: R. Negro); Taczanowski, Orn. Pér. ii. p. 74 (Tarapoto, N. Peru).

Gymnopathys leucaspis Salvin & Godman, Biologia, Aves, ii. p. 222 (Rio Meta, East. Colombia).

This species is exclusively found in the forests of Upper Amazonia, from the eastern slopes of the Colombian Andes south to Northern Peru. Both Natterer and Wallace obtained it on the banks of the Rio Negro, while Wheeler transmitted specimens from the Rio Meta, E. Colombia, to the British Museum. Hauxwell met with it at Chamicuros, Eastern Peru, and E. Bartlett procured a series at Chyavetas, Xeberos, and Chamicuros, now in the Tring Museum. *A. leucaspis* is also occasionally found in the trade-collections sent from Bogotá to Europe.

Against the statement in the 'Cat. of Birds,' xv. p. 295, I wish once more to emphasize that it is the *female* which possesses the cinnamomeous interscapular blotch. Five sexed males from Northern Peru (Chamicuros, Chyavetas, Xeberos; Bartlett coll.) in Mr. Rothschild's collection, five from the Rio Negro, obtained by Natterer, in the Vienna Museum, and one male from Cobati, R. Negro, Wallace coll. in the British Museum, show no trace of it; while in five sexed females from the Rio Negro (Natterer; Vienna Museum) there is a large conspicuous patch at the base of the dorsal feathers. Besides the above, I have examined two males and four females from "Bogotá-coll." in the collections at Tring, Munich, and Paris.

(2) ANOPILOPS BICOLOR ÆQUATORIALIS Hellm.

Pithys bicolor æquatorialis Hellmayr, Orn. Monatsber. x. p. 33 (1902.—Lita, N.W. Ecuador).

P. leucaspis (nec Sclater) Hartert, Nov. Zool. v. 1898, p. 493 (Chimbo, W. Ecuador); Goodfellow, Ibis, 1902, p. 65 (Sto. Domingo, W. Ecuador).

Gymnopathys ruficeps (nec Salvin & Godman) Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 32 (Santiago, W. Ecuador); Hartert, Nov. Zool. ix. 1902, p. 613 (Chimbo, Paramba, S. Javier, W. Ecuador).

This form, which is confined to Western Ecuador, shares with *A. leucaspis* the bright ferruginous colour of the forehead and crown, but is much darker rufous brown on the back, has the sides of the occiput dark cinereous, etc., etc. I have examined twenty specimens from W. Ecuador in the Tring, Vienna, and Munich Museums. There is never any trace of a pale interscapular patch.

(3) ANOPLUPS BICOLOR RUFICEPS Salv. & Godm.

Gymnophithys ruficeps Salvin & Godman, Biologia, Aves, ii. p. 222 (1892.—"Cauca Valley," the types are from Neche and Remedios, Antioquia).

Pithys leucaspis (nec Sclater) Sclater & Salvin, P. Z. S. 1879, p. 526 (Remedios, Neche).

This race is evidently confined to the Cauca Valley in the province of Antioquia, N. Colombia. Besides three of Salmon's skins in the British Museum (2) and at Tring (1), I have examined five Bogotá skins * referable to the same form. *A. b. ruficeps* differs at a glance from the preceding subspecies in lacking the cinereous colour on the sides of the occiput and in the white of the chest being laterally not bordered with black. It is much more closely related to *A. b. olivascens*, but of a more rufescent colour throughout.

(4) ANOPLUPS BICOLOR DAGUÆ Hellm.

This well-marked form also has a very limited range, being known only from the valleys of the Dagua and San Juan Rivers in Western Colombia. The Tring Museum possesses an adult male obtained by E. André near Buenaventura, and another from Juntas, Raap coll. Palmer's three specimens are the only others on record. For characters see above.

(5) ANOPLUPS BICOLOR BICOLOR Lawr.

Pithys bicolor Lawrence, Ann. Lyc. N. H. N.Y. viii. p. 6 (1863.—Panama Railway).

The "typical" subspecies also has a rather limited distribution, being restricted to Panama and Veragua. I have examined four skins from the Panama Railroad (*McLeannan*), one from Chepo, and one from Santa Fé, Veragua (*Arcé*), all in the British Museum.

(6) ANOPLUPS BICOLOR OLIVASCENS Ridgw.

Pithys bicolor olivascens Ridgway, Proc. U. S. Nat. Mus. xiv. 1891, p. 469 (1892.—Santa Ana, Honduras).

This form is more widely distributed, ranging from Eastern Honduras through Nicaragua, and Costa Rica to Chiriqui. There are large series from various localities in the Tring and Munich Museums.

130. FORMICARIUS ANALIS DESTRUCTUS Hart.

[*Myothera analis* Lafresnaye & D'Orbigny, Syn. Av. i., in Mag. Zool. cl. ii. p. 14 (1837.—Yuracarès, N.E. Bolivia).]

Formicarius analis destructus Hartert, Nov. Zool. v. p. 493 (1898.—Paramba, N.W. Ecuador); idem, l. c. ix. 1902, p. 614 (N.W. Ecuador; crit.).

F. analis (nec Lafr. & D'Orb.) Sclater, P. Z. S. 1860, p. 294

* One in Tring, two in the Paris Museum, two in the British Museum.

(Esmeraldas, N.W. Ecuador); idem, Cat. B. Brit. Mus. xv. p. 304 (part.: Balzar, Santa Rita; Esmeraldas: W. Ecuador).

F. nigricapillus (nec Ridgway) Ridgway, Proc. U.S. Mus. xvi. p. 675 (part.: sp. ex Santa Rita).

F. destructus Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 32 (Peripa, W. Ecuador).

Nos. 2508, 2393. ♂ ♂ ad. Nóvita: 11.xii.08, 30.i.09.—Wing 90, 86; tail 55, 52; bill 20, 21 mm.

No. 2372. ♀ juv. Nóvita: 5.xii.08.—Wing 86; bill 18 mm.

"Iris dark brown, feet and bill black."

Perfectly identical with topotypical specimens from Paramba, N.W. Ecuador, the head all round and the hind-neck being sooty black, abruptly contrasting with the dark rufous brown of the back.

F. a. destructus is most nearly allied to *F. a. nigricapillus* Ridgw. of Eastern Costa Rica. Dr. Hartert * having clearly pointed out the differences between the two races, I need not dwell any more upon the subject.

This *Formicarius* is confined to the lowlands and foot-hills of the Pacific coast of Colombia and Ecuador. On the other side of the Western Cordillera, in the Cauca Valley, another species or subspecies, *F. saturatus* Ridgw. †, takes its place. I have examined the example from Remedios (*Salmon*) in the British Museum, and an adult male obtained by the late J. H. Batty at Los Jambos (Cauca Valley) in Mr. Rothschild's Museum at Tring, which I cannot distinguish from typical Trinidad specimens. *F. saturatus* is much paler grey underneath, has the sides of the neck distinctly cinnamonaceous, and the top of the head light olivaceous brown like the back, besides some minor differences.

131. FORMICARIUS RUFIPECTUS RUFIPECTUS Salv.

F. rufipectus Salvin, P. Z. S. 1866, p. 73, pl. viii. (1866.—Santiago de Veragua); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, 1899, p. 33 (Gualea, W. Ecuador); Ménégau & Hellmayr, Bull. Soc. Philom. Paris, (9) viii. 1906, p. 52 (between Esmeraldas and Pachijal, Oyacachi, W. Ecuador); Carriker, Ann. Carnegie Mus. vi. 1910, p. 626 (Rio Cali, W. Colombia).

No. —. ♂ ad. Pueblo Rico: 16.viii.09.—Wing 99; tail 63; bill 20 mm.

No. 2729. ♀ ad. Pueblo Rico: 16.viii.09.—Wing 94; tail 59; bill $21\frac{1}{2}$ mm.

"Iris and feet dark brown, bill black."

These specimens agree well with others from Chiriqui (A. Lara coll.). The female differs from the male, in addition to its smaller size, by having the breast somewhat clearer rufous, and

* Nov. Zool. ix. p. 614.

† Proc. U.S. Mus. xvi. p. 677 (1894.—Trinidad (type); Venezuela: S. Esteban; N.E. Colombia: Remedios).

the crown dull brownish black, the hind neck only being washed with chestnut, while in the male all the top of the head, from the forehead to the nape, is dark chestnut-maroon. The sexual differences noticed by Mr. Carriker, however, do not hold good. Both specimens have the middle of the belly extensively ochraceous buff and the flanks dark smoky grey.

This scarce species ranges from Central Costa Rica (Juan Viñas) to Western Ecuador*. On the eastern (Amazonian) slopes of the Ecuadorian Andes and in Peru, *F. r. rufipectus* is replaced by *F. r. thoracicus* Tacz. & Berl.†, at once recognizable by its deep black pileum. I have examined one of the typical specimens and an adult male from Huaynapata, both in Count Berlepsch's collection.

132. *PITTASOMA ROSENBERGI* Hellm.

P. rosenbergi Hellmayr, Rev. Franç. d'Orn. ii. p. 51 (April 1911.—Sipi, Rio Sipi).

♂ *ad.* Pileum and nape deep cinnamon-rufous; back and scapulars dull olive, more brownish on the rump, each feather broadly bordered with black on either side, giving the upper parts a striped appearance; some of the interscapular feathers white at the base; upper wing-coverts sepia-brown, washed with russet, especially on the outer webs, each feather with a small, but distinct, whitish apical spot, and with a distinct black margin round the tip; primary coverts uniform blackish brown; remiges blackish, with the outer web dull russet-brown; rectrices dusky, the central ones washed with russet. Lores and broad superciliary stripe, reaching to the sides of the neck, uniform deep black; cheeks, subocular and malar region, ear-coverts, chin and throat ochraceous, rather deeper on the sides of the head; fore-neck and sides of the breast and flanks dull olive-brownish; middle of the breast and abdomen uniform buffy white, this colour being separated from the ochraceous throat by the dull brown crescent of the foreneck; under tail-coverts hair-brown, edged with whitish; axillaries and under wing-coverts dusky brown, the under primary-coverts tipped with white.

"Iris dark brown, feet and bill black."

Wing 97; tail 34; tarsus 45; bill $24\frac{1}{2}$ mm.

Type in the Zoological Museum, Munich, No. 09.5759. ♂ *ad.* Sipi, Rio Sipi, alt. 150 feet, Sept. 25, 1908. Mervyn G. Palmer coll. no. 2120.

This species, which is named in honour of Mr. W. F. H. Rosenberg, of London, who organized Mr. Palmer's expedition to Western Colombia, is unfortunately represented by a single specimen only. The type is a perfectly adult male, as shown by the

* The specimen in the British Museum said to be from Baeza (Eastern Ecuador) either belongs to *F. r. thoracicus*, or else the locality is wrong (Buckley!).

† *F. thoracicus* Taczanowski & Berlepsch, P. Z. S. 1885, p. 101 (Machay, Eastern Ecuador); Salvadori & Festa, Boll. Mus. Zool. Torino, xiv. no. 362, p. 33 (S. José, E. Ecuador); Berlepsch & Stolzmann, Ornith. xiii. 2. 1906, p. 118 (Huaynapata, S.E. Peru).

uniform blackish primary coverts, the whitish apical spots to the wing-coverts, the black superciliary stripe, etc. Although closely allied to *P. rufopileatum* Hart.*, from North-western Ecuador, it differs from both sexes of that species† in having no dusky cross-bands whatever on the lower parts. In *P. rufopileatum* the male has the under surface of the body, with the exception of the flanks, regularly barred with black and white, the black markings of the throat being often broken and less pronounced, though always present, while only the sides of the head are ochraceous. The superciliary stripe (uniform black), back and upper wing-coverts are exactly as in *P. rosenbergi*. The female of *P. rufopileatum* agrees with the latter in the ochraceous throat, but can, of course, be easily distinguished by having the feathers of the superciliary region white, edged with black, and the lower parts (posterior to throat) bright ochraceous narrowly banded across with dusky olive. Besides, the back is much more decidedly brown, and the apical spots to the wing-coverts are bright buff instead of white.

133. CONOPOPHAGA CASTANEICEPS CASTANEICEPS Scl.

Conopophaga castaneiceps Sclater, P. Z. S. xxiv. p. 47 (1857—part., type from Bogotá, Colombia; = ♂).

C. gutturalis idem, l. c. 1868, p. 574 (Bogotá; = ♀).

No. 3779. ♀ ad. La Selva, Rio Jamaraya, 4600 ft., 1.x.09.—Wing 72; tail 39; bill $14\frac{1}{2}$ mm.

"Iris dark brown, feet grey, maxilla black, mandible grey."

This bird corresponds with Sclater's description of *C. gutturalis*. It has the back rather more brownish than a Bogotá skin, but does not differ otherwise. This is, so far as I know, the first record of *C. castaneiceps* from the Western Cordillera of Colombia.

In Peru it is replaced by a closely allied form, *C. c. brunneinucha* Berl. & Stolz.‡ The female of *C. c. castaneiceps*, in general coloration, is much like *Grallaricula cucullata* Scl., but may easily be recognized by its white postocular stripe ("pencil").

134. ANDRODON ÆQUATORIALIS Gould.

Androdon æquatorialis Gould, Ann. Mag. N. H. (3) xii. p. 247 (1863.—Ecuador); Sclater & Salvin, P. Z. S. 1879, p. 528 (Remedios, Antioquia).

No. 2129. ♂ ad. Sipi, Rio Sipi: 29.ix.08.—Wing 67; tail 42; bill 40 mm.

Nos. 2074, 2644. ♂ ♂ imm. Sipi: 10.ix.08; Tadó: 8.v.09.—Wing 68, 69; tail 42, 44; bill 37, 40 mm.

"Iris black, feet pink, maxilla black, mandible light yellow."

The first specimen (No. 2129) has the forehead and crown

* Novit. Zool. viii. p. 370 (1901.—Bulón, N.W. Ecuador).

† The bird figured in Nov. Zool. ix. 1902, pl. viii. fig. 2 as "juv." is really the adult female. This is quite evident from the large series, partly in the Tring Museum, partly in the possession of Mr. Rosenberg, which I have examined.

‡ P. Z. S. 1896, p. 355 (Garita del Sol, La Gloria, Chanchamayo, C. Peru).

shining coppery red, passing into golden green on the occiput; in the two other, apparently immature, birds the forehead is dull greyish, while the feathers of the crown are dusky, tipped with bronze-green and edged with reddish bronze. No. 2074 shows a strong bluish tinge on the nape, completely absent in the other examples.

With regard to the variation of this species, *cfr.* Simon, Bull. Mus. Paris, 1907, no. 1, p. 17.

A. æquatorialis is strictly confined to the lowlands and hill-ranges of Western Ecuador and Colombia, ranging from near sea-level up to about 2400 feet.

135. *THRENETES RUCKERI FRASERI* Gould.

[*Trochilus Ruckeri* Bourcier, P. Z. S. 1847, p. 46 (May 1847—loc. ign.)*.]

Glaucis fraseri Gould, Monogr. Trochil. pt. xxiv. pl. 12 (1861.—Esmeraldas, N.W. Ecuador).

Threnetes fraseri Hartert, Nov. Zool. v. 1898, p. 493 (Cachabi, N.W. Ecuador); Bangs, Proc. Biol. Soc. Wash. xxiii. 1910, p. 72 (Naranjito, Rio Dagua; Palmer coll.).

Threnetes ruckeri (sic) Boucard, 'Humming Bird,' v. 1895, p. 7 (Rio Dagua).

No. 2417. ♂ fere ad. Nóvita, 150 ft., 19.xii.08.—Wing 60; tail 38; bill 31 mm.

"Iris black, feet pink, maxilla black, mandible yellow."

The differences separating *T. r. ruckeri* and *T. r. fraseri* are so slight that their relationship is better expressed by trinomials. One of the principal characters given by authors for the southern bird, namely, the lesser extent of the cinnamon-rufous patch on the foreneck, is of no value at all. *Adult* males of *fraseri* have quite as much, sometimes even more, rufous on the jugulum than Central American skins. The only constant points by which to tell *fraseri* are the rather darker smoke-grey belly, the pure metallic green upper parts, without any bronzy or golden gloss, and the much deeper, decidedly bluish-black colour of the median portion of the lateral rectrices.

Specimens from Western Ecuador have the two central rectrices dull green, passing to nearly blackish green towards the tip, while in the male from Nóvita they are much brighter, uniform metallic green. In that respect the Chocó bird slightly points towards *ruckeri* from Central America, but otherwise it is perfectly typical of *fraseri*.

T. r. fraseri inhabits the forest-covered lowlands of Western Colombia and Western Ecuador†, from sea-level up to about 700 feet.

* Bourcier's rather vague description is possibly not referable to the present species. The words "gorge et dessous du corps gris-noir bronzé" can scarcely be applied to *T. ruckeri* auct., and a re-examination of the type in the Loddiges Collection seems desirable.

† Its reported occurrence in Eastern Ecuador (Sarayacu: *cfr.* Cat. B. xvi. p. 266) rests on two of Buckley's skins, no doubt incorrectly labelled.

136. *GLAUCIS HIRSUTA* *ÆNEA* LAWY.

[*Trochilus hirsutus* Gmelin, Syst. Nat. 1, i. p. 490 (1788—*ex* Marcgrave: East Brazil).]

Glaucis æneus Lawrence, Proc. Ac. N. Sci. Philad. xix. p. 232 (1867.—Costa Rica).

G. columbiana Boucard, Gen. Hum. Birds, p. 402 (end of 1895.—Rio Dagua, W. Colombia); idem, 'The Humming Bird,' v. p. 7 (Rio Dagua).

G. hirsuta (nec Gmelin) Sclater & Salvin, P. Z. S. 1879, p. 528 (Santa Elena).

No. 1985. ♂ (?) ad. Guineo, Rio Calima: 10.viii.08.—Wing 54½; tail 34; bill 29 mm.

"Iris black, feet yellow, maxilla black, mandible yellowish grey."

I agree with Mons. Simon* that the earliest available name for the small, dark-coloured form of the Pacific coast is the one given above. I am unable to find any constant differences, either in size or in colour, between examples from N.W. Ecuador and W. Colombia, on the one hand, or those from Central America on the other. The uniform cinnamon-brown colour of the under parts is by no means a constant character of the Western birds, as already pointed out by Mr. Oberholser†.

G. h. ænea ranges from Costa Rica and Panama south to N.W. Ecuador (province of Esmeraldas).

137. *PHÆTHORNIS YARUQUI SANCTI-JOHAANNIS* Hellm.

[*Trochilus Yaruqui* Bourcier, Compt. Rend. Ac. Sc. Paris, xxxii. No. 6 (séance 10 Febr.), p. 187 (1851.—"Les bois très-chauds des environs d'Yaruqui," W. Ecuador).]

Phaethornis yaruqui sancti-johannis Hellmayr, Bull. B. O. C. xxvii. p. 92 (1911.—Condoto).

Phaethornis yaruqui (nec Bourcier) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 194 (R. Truando); Simon & Dalmas, Ornith., xi. p. 218 (Buenaventura).

Nos. 2128, 2197, 2344, 2598 ‡. ♂ ♂ ad., ♂ nearly ad. Sipi: 29.ix.; Noanama: 17.x.; Nóvita: 27.xi.08.; Condoto: 14.iv.09.—Wing 61–62; tail 55–61; bill 41–43 mm.

Nos. 1987, 2042, 2095. ♀ ad., ♀ ♀ imm. Guineo: 11.viii.; Noanama: 31.viii.; near Sipi: 19.ix.08.—Wing 58–59; tail 59–63; bill 37–40 mm.

"Iris black, feet brown, maxilla black, mandible scarlet."

Type of subspecies in Zoological Museum, Munich: no. 09. 5807. ♂ ad. Condoto, R. Condoto, 150 feet, April 14, 1909. M. G. Palmer coll. no. 2598.

P. y. sancti-johannis is a very distinct form, differing in many

* Rev. Franç. d'Orn. i. 1910, p. 260.

† Proc. U.S. Mus. xxiv. 1902, p. 311.

‡ Type of subspecies.

important points from *P. y. yaruqui* of Western Ecuador. The males may be distinguished by their shorter bill; much broader and darker, deep ochreous-buff postocular and malar streaks; and by having the pale smoke-grey median stripe of the throat and foreneck much wider and confluent with the smoke-grey abdomen, which is but slightly spotted with metallic green on the flanks; whereas in *P. y. yaruqui* the under surface is mainly dark metallic green, with the abdomen and a short stripe along the middle of the throat sooty blackish. The Chocó birds have, too, the base of the outer web of the rectrices decidedly washed with greenish. The females are even more different from the Ecuadorian *yaruqui*. The under surface is light mouse-grey, the sides of the foreneck and breast being but sparingly mottled with metallic green, and the pale median stripe along the throat, foreneck, and chest is conspicuously mixed with whitish. The deep ochreous-buff postocular stripe is much broader, the white tip to the central rectrices more extended, but less sharply defined than in the females of *P. y. yaruqui*. In the females of both races, the malar streak is white, anteriorly tinged with buff.

Mons. Simon, of Paris, to whom I have submitted our series, agrees to the distinctness of the Colombian race.

P. y. sancti-johannis replaces the typical form in the tropical lowlands of West Colombia (from the Truando to Buenaventura),

138. *PHÆTHORNIS SYRMATOPHORUS SYRMATOPHORUS* Gould.

Phaethornis syrmatophorus Gould, Contrib. to Ornith. 1851, p. 139 (1851.—“Interior of Quito, in Ecuador,” W. Jameson coll.).

P. syrmatophorus Scater & Salvin, P. Z. S. 1879, p. 528 (Santa Elena, Medellin, Antioquia); Simon & Dalmas, Ornith. xi. 1901, p. 217 (La Tigra, Las Cruces, Western Cordillera).

P. berlepschi E. & Cl. Hartert, Nov. Zool. i. p. 56 (1894.—Rio Pescado, W. Ecuador).

No. 3782. ♂ imm. La Selva, Rio Jamaraya, 4600 ft., 2.x.09.—Wing 62; tail 75; bill 41 mm.

“Iris black, feet brown, maxilla black, mandible scarlet with black tip.”

This bird, as well as Salmon's skins from Medellin and Santa Elena in the British Museum, agrees with examples from Western Ecuador upon which Hartert's *P. berlepschi* was based. I regret to say, however, that this name is a synonym of *P. s. syrmatophorus* while the eastern form has to bear the subspecific term *columbianus* Boucard*, as already pointed out by Salvadori & Festa†. Gould established the species upon specimens obtained by Prof. Jameson. There are three skins from this source in the Gould Collection (now in the British Museum): one, marked “Napo—Jameson,”

* *Phaethornis columbianus* Boucard, ‘The Humming Bird,’ i. p. 17 (1891.—Bogotá; type in Paris Museum examined).

† *Phaethornis syrmatophorus* Salvadori & Festa, Boll. Mus. Zool. Torino, xv. no. 368, 1900, p. 3 (Gualea, W. Ecuador).

belongs to the eastern race, *P. s. columbianus*, having the malar streak and a broad stripe down the middle of the lower surface, from the chin to the anal region, clear white, and the rump as well as the upper tail-coverts uniform ochraceous buff; the two others, labelled "Ecuador—Jameson," agree with the so-called "*berlepschi*" from W. Ecuador, having the malar streak bright buff, the rump feathers green with buff edges, and the whole of the lower parts, with exception of a white stripe along the middle of the throat, ochraceous buff. As will be easily seen from Gould's account, his description is a *mixtum compositum*, the characters of the lower parts ("chest, abdomen, and under tail-coverts rich buff") being taken from the western form (*berlepschi*), while the words "*rump* and upper tail-coverts rich buff" apply only to the eastern *columbianus*. Since no marked type of *P. symmatophorus* exists, M. Boucard was perfectly justified—according to the rule of the first reviser—in restricting the name to one of the components, and his name *columbianus* has to stand for the eastern race. Thus we have:—

- (a) *P. s. symmatophorus* (Gould) (syn. *berlepschi* Hart.). Western Ecuador (Guala, Rio Pescado, etc.) and Western Cordillera of Colombia (La Selva, La Tigra, Las Cruces, Medellin, Santa Elena, etc.).
- (b) *P. s. columbianus* Boucard. Eastern Ecuador (Rio Pastaza etc.), and Eastern Cordillera of Colombia (Bogotá coll.).

139. *EUTOXERES AQUILA SALVINI* Gould.

[*Trochilus Aquila* Bourcier, P. Z. S. 1847, p. 42 (1847—"les environs de Bogotá").]

Eutoxeres salvini Gould, Ann. Mag. N. H. (4) i. p. 456 (1868.—Veragua).

E. aquila (nec Bourcier) Simon & Dalmas, Ornith. xi. p. 218 (Plano de los Monos, Western Cordillera).

No. 2445. ♂ ad. Noanama, 100 ft., 5.i.08.—Wing 76; tail 54; bill 30½ mm.

"Iris black, feet black, plantar surface yellow, maxilla black, mandible yellow."

This bird belongs to *E. a. heterura*, as defined by Hartert & Hartert*, having much less white in the tail than Bogota-skins (=true *E. a. aquila*). Messrs Salvadori & Festa† cast some doubts on the distinctness of *E. baroni* Hart. & Hart.‡, and take this "species" for the young of the ordinary *heterura* (sensu Hartert). I have neither material nor time to enter into that question now: but whatever the specimens with an olive-grey tail and minute, if any, white spots to the rectrices may be, there can be no doubt that it is to this form that Gould's term *E. heterura* has to be restricted. Although Gould, in the introductory

* Nov. Zool. i. 1894, pp. 53–54.

† Boll. Mus. Zool. Torino, xv. no. 368, 1900, p. 2.

‡ Nov. Zool. i. p. 54 (1894.—Rio Pescado, Naranjal, Ecuador).

remarks to his paper, alludes to the variability of the tail-markings, yet the formal description (*l. c.* p. 456) of *E. heterura* clearly refers to the birds afterwards separated as *E. baroni*, *cfr.* especially the words: "tail olive-grey, in some instances tipped with sullied white."

The next available name for *E. heterura* Hart. (nec Gould) seems to be *E. salvini* Gould, based upon specimens from Veragua which I cannot satisfactorily distinguish from those taken in W. Colombia and W. Ecuador.

140. *FLORISUGA MELLIVORA MELLIVORA* Linn.

Trochilus mellivorus Linnæus, Syst. Nat. x. p. 121 (1758—*ex* Edwards: Surinam).

Florisuga mellivora Simon & Dalmás, Ornith., xi. p. 218 (Las Cruces, West. Cordillera); Sclater & Salvin, P. Z. S. 1879, p. 529 (Remedios).

Nos. 2055, 2238. ♂ ad., ♂ imm. Noanama: 3.ix.; Cajón, R. Cajón: 3.xi.08.—Wing 66, 65; tail 38, 35; bill 18, 19 mm.

"Iris, feet, and bill black."

We have also a number of skins obtained by the late J. H. Batty on the Rio Zapotá, in August and September 1898.

F. mellivora is a wide-spread species.

141. *POLYERATA ROSENBERGI* Bouc.

Polyerata rosenbergi Boucard, Genera of Humming Birds, p. 399 (end of 1895.—Rio Dagua, W. Colombia): *idem*, 'The Humming Bird,' v. Dec. 1895, p. 6.

Nos. 2247, 2351. ♂ ♂ ad. Nóvita: 7, 28.xi. 08.—Wing 55, 56½; tail 30, 34; bill 22, 20½ mm.

No. 2551. ♂ ad. Juntas (Rio Tamañá): 20.ii.09.—Wing 57; tail 32; bill 20 mm.

No. 2570. ♂ ad. Rio Condoto: 26.iii.09.—Wing 55; tail 31½; bill 21 mm.

No. 2373. ♂ imm. Nóvita: 5.xii.08.—Wing 55; tail 32; bill 20 mm.

No. 2255. ♀ ad. Nóvita: 9.xi.08.—Wing 50½; tail 29; bill 21 mm.

"Iris, bill, and feet black."

The original examples, obtained by Mr. Rosenberg in the same district in 1894, were all more or less immature. The fine series now forwarded by Mr. Palmer enables me to state that none of the characters which served to distinguish the Ecuadorian race *P. r. reini** holds good, and I am afraid the latter name will have to be placed as a synonym of *P. rosenbergi*. Thanks to the kindness of Dr. von Lorenz, of the Vienna Museum, I have been able to examine a series of seven specimens of the so-called *reini*: 2 ♂ ♂ ad., 2 ♂ ♂ imm., 3 ♀ ♀, all from N.W. Ecuador†. The

* *Polyerata reina* Berlepsch, Orn. Monatsber. v. p. 58 (1897.—Western Ecuador).

† They are from the following localities: Carondelet (60 ft.), Bulún (60 ft.), San Javier (60 ft.), Pambilar (60 ft.), Charco Redondo (160 ft.).

adult males from W. Colombia have the throat and foreneck of exactly the same golden green hue as the Ecuadorian ones, while the violet-blue pectoral area, in the latter, is by no means less extended. There is no difference in the development of the bronzy base to the outer rectrices between the two series, and the dimensions are practically the same. The female from Nóvita differs from the three "*reini*" (ex Ecuador) by having the throat less spotted with shining green, though this is very insignificant.

Measurements :—

<i>P. rosenbergi.</i>			
	Wing.	Tail.	Bill.
	mm.	mm.	mm.
Four adult males from W. Colombia ...	55-57	30-34	20½-22
One immature male " " ... "	55	32	20
One female " " ... "	50½	29	21

"*P. reini*."

Two adult males from N.W. Ecuador ...	53, 55	30, 32	22
Two immature males " " ... "	53, 54	32	21
Three adult females " " ... "	50-52	27, 28	21-22

P. rosenbergi is thus found to range over the humid, tropical coast-district of N.W. Ecuador and W. Colombia.

142. URANOMITRA FRANCIE Bourc. & Muls.

Trochilus Francie Bourcier & Mulsant, Ann. Sci. phys. et nat., d'Agric. et d'Industr. Lyon, ix. p. 324 (1846.—Bogotá; descr. ♂ ad.)

Cyanomyia francie Sclater & Salvin, P. Z. S. 1879, p. 530 (Antioquia).

Agyrtria Francie Simon & Dalmas, Orn. xi. p. 218 (La Tigra, Western Cordillera).

Uranomitra francie Boucard, 'The Humming Bird,' v. p. 6 (Rio Dagua).

Nos. 2733, 2736, 3756. ♂ ♂ ad. Pueblo Rico, 5200 ft., 16, 18.viii.; Siató: 15.ix.09.—Wing 55; tail 35, 36; bill 21-24 mm.

No. 2735. (♂) juv. Pueblo Rico: 18.viii.09.—Wing 56; tail 34 mm.

" Iris and feet black, maxilla black, mandible brown, tip black."

Similar to Bogotá-skins.

U. francie is as yet known only from the mountains of Colombia.

143. AMAZILIA TZACATL JUCUNDA Heine.

[*Trochilus Tzacatl* De la Llave, Registro Trimestre, ii. No. 5, p. 48 (1833.—Mexico) *.]

Eranna jucunda Heine, Journ. f. Orn. xi. p. 188 (1863.—Babahoyo & Esmeraldas, W. Ecuador).

* Cf. Richmond, Auk, xvi. 1899, p. 324.

Amazilia fuscicaudata (nec Fraser) Boucard, 'The Humming Bird,' v. p. 7 (Rio Dagua).

A. riefferi Sclater & Salvin, P. Z. S. 1879, p. 530 (Antioquia); Simon & Dalmás, Ornis, xi, p. 221 (Naranjo).

Nos. 2056, 2057, 2075, 2488. ♂ ♂ ad. Noanama: 3.ix.08.; Nóvita: 23.i.09; Rio Sipi: 10.ix.08.—Wing 57–59; tail 35–36; bill $21\frac{1}{2}$ –22 mm.

No. 2410. ♀ juv. Nóvita: 18.xii.08.—Wing 57; tail 34; bill 22 mm.

"Iris and feet black, bill brown, tip black; maxilla black in the young bird."

Identical in colour and dimensions with specimens from Western Ecuador.

A. t. jucunda, which inhabits the low countries of Western Ecuador and Western Colombia, agrees with the typical Central American race in shape and length of the bill, but may be distinguished by having the upper mandible fleshy brown (instead of blackish), and the abdomen conspicuously darker smoke-grey.

A. t. fuscicaudata, from Eastern Colombia (Bogotá) and the mountains of Merida, is much smaller, and has a considerably shorter, stouter bill.

144. CHLOROSTILBON PUMILUS Gould.

Chlorostilbon pumilus Gould, Ann. Mag. N. H. (4) ix. p. 195 (1872.—Citado and Pallatanga, W. Ecuador); Simon & Dalmás, Ornis, xi. p. 221 (Naranjo, La Tigra, Western Cordillera of Colombia).

C. angustipennis (errore) Sclater & Salvin, P. Z. S. 1879, p. 531 (Medellin).

No. 2732. ♂ ad. Pueblo Rico: 16.viii.09.—Wing and tail in moult; bill $13\frac{3}{4}$ mm.

"Iris, feet, and bill black."

This specimen is typical of *C. pumilus*, which had already been obtained in the same region by Eugène André, as well as further north, in Antioquia, by the late T. K. Salmon. Topotypical birds from Ecuador I have not seen.

C. pumilus inhabits the mountainous ranges of Ecuador and Western Colombia.

145. THALURANIA FANNYI Del. & Bourc.

Trochilus Fannyi Delattre et Bourcier, Rev. Zool. ix. p. 310 [1846—"les bords de la rivière de Dagua, près Saint-Bonaventure (Nouvelle-Grenade)"].

Thalurania Fannixæ Simon & Dalmás, Ornis, xi. p. 221 (Buena-ventura, El Paillon, Naranjo); Boucard, 'The Humming Bird,' v. p. 6 (Rio Dagua).

No. 2814. ♂ ad. Pueblo Rico, 5200 ft., 26.x.09. Wing 55; tail 39; bill 20 mm.

Nos. 2443, 3773. ♂♂ imm. Noanama, 100 ft., 4.i.; Siató, 5200 ft., 24.ix.09.—Wing 54; tail 39, 36; bill 20, 18 mm.

Nos. 2051, 2447. ♀♀ ad. Noanama: 2.ix.08, 5.i.09.—Wing 50, 51; tail 31, 32½; bill 20 mm.

"Iris and bill black; feet in males black, in females grey."

The differences between *T. fannyi* and *T. verticeps* Gould*, from Western Ecuador, have been well pointed out by Simon & Dalmas. The adult male shows all the characters assigned to *fannyi*, viz, the very dark, almost black colour of the occiput and mantle, the nearly complete, violet-blue interscapular band, the deeply forked tail, etc. The blue margin bordering posteriorly the glittering green crown† is not a constant feature, it being well developed in No. 3773, scarcely indicated in No. 2443, and completely absent in No. 2814 (♂ ad.). Both of the females have the shining bluish shoulder-patch as described by Simon & Dalmas.

T. fannyi is restricted to Western Colombia, ranging from sea-level up to about 5000 feet in the western slope of the Coast Cordillera‡. In Western Ecuador it is replaced by *T. verticeps* Gould, which may be only subspecifically separable.

146. CHALYBURA UROCHRYSA Gould.

Hypuroptila urochrysa Gould, P. Z. S. 1861, p. 198 (1861.—"Panama").

Chalybura buffoni (errore) Scater & Salvin, P. Z. S. 1879, p. 529 (Remedios, Santa Elena).

H. urochrysea Salvin, Cat. B. Brit. Mus. xvi. p. 89 (Medellin, Remedios).

Chalybura urochrysea Hartert, Nov. Zool. v. 1898, p. 494 (Cachabi, N.W. Ecuador).

Nos. 2083, 2329, 2581. ♂♂ ad. Sipi: 12.ix.08; Nóvita: 23.xi.08; Condoto: 1.iv.09.—Wing 67–70½; tail 42–46; bill 23½–24 mm.

No. 2218. ♂ imm. Rio Cajón: 28.x.08.—Wing 68½; tail 42; bill 24 mm.

Nos. 2091, 2099, 2161, 2221. ♀♀ ad. Sipi: 18, 21.ix., 6.x.08; Rio Cajón: 29.x.08.—Wing 62–66; tail 38–42; bill 21½–24 mm.

"Iris black, feet pink, maxilla black, mandible pink (♀), light brown (♂)."

This rare species is easily recognizable by its bronze-green tail, combined with the pale mandible. The females have the six outer tail-feathers distinctly tipped with greyish white, and the under tail-coverts pale mouse-grey (brownish grey). The specimens obtained by Salmon in Antioquia I have examined

* In Jardine's Contrib. to Ornith. 1851, pt. ii. p. 79, pl. lxxi. (Apr. 1851.—Quito, Ecuador).

† Cfr. Hartert, Tierreich, livr. 9, 1900, p. 85.

‡ The reported occurrence at Popayan and Pasto (!) does not rest upon reliable authority.

in the British Museum, and found them to belong to the present species. Strangely enough, they had been determined by Salvin as *C. buffoni*.

C. urochrysa is, according to our actual knowledge, confined to the dense forests along the Pacific coast of N.W. Ecuador and W. Colombia *. It is particularly common in the lowlands, though Salmon also procured examples near Remedios, at 2300 feet elevation.

At higher altitudes, however, in the Western Cordillera another species of *Chalybura* occurs, specimens of which were obtained at Rio Dagua † by Rosenberg, and at Naranjé ‡ by E. André. It agrees with *C. buffoni* from Bogotá, in the coloration of the tail (rectrices bluish black, more or less edged with bronze green) and lower parts, but has the lower mandible mostly pale brownish, like *C. urochrysa*. With only a single example before me I refrain, however, from naming this apparently undescribed form.

147. BOISSONNEAU FLAVESCENS FLAVESCENS Lodd.

Trochilus flavescens Loddiges, P. Z. S. 1832, p. 7 (1832.—Popayan, Colombia).

Panoplitus flavescens Scater & Salvin, P. Z. S. 1879, p. 529 (Medellin).

No. 2793. ♂ ad. Tatamá Mountain, 8000 ft., 12.x.08.—Wing 80; tail 52; bill $17\frac{1}{2}$ mm.

“Iris, feet, and bill black.”

This bird fully agrees with Bogotá skins except that the green tip to the inner web of the outermost rectrix is a trifle longer. Ecuadorian specimens have much broader green tips to the lateral rectrices, and the buff portions of the tail as well as the under tail-coverts are deeper in tint. They have been separated by Mr. Oberholser as *B. f. tinochlora* §.

148. ERIOCNEMIS AURELLE Bourc. & Muls.

Trochilus Aureliæ Bourcier & Mulsant, Ann. Sci. phys. et nat., d'Agric. et d'Industr. Lyon, ix. p. 315 (1846.—Bogotá).

Eriocnemis aureliæ Scater & Salvin, P. Z. S. 1879, p. 530 (Santa Elena, Medellin).

No. 2737. ♂ juv. Pueblo Rico, 5200 ft.: 6.ix.08.—Wing 63; tail 40; bill 19 mm.

“Iris black, feet grey, bill black.”

Notwithstanding its rather long bill, this specimen appears

* The original locality “Panama” is open to doubt. Warscewicz was very careless about labelling, and, moreover, not one of the many later travellers met with the species on the Isthmus.

† *Hypopoptila buffoni* Boucard, ‘The Humming Bird,’ v. 1895, p. 8 (specimen examined by me).

‡ *Chalybura buffoni* Simon & Dalmas, Ornith., xi. p. 222 (Naranjé, 1900 ft.).

§ Proc. U. S. Mus. xxiv. p. 329 (1902.—West side of Corazón, Ecuador).

to belong to the present species, for in coloration it closely resembles several Bogotá skins in corresponding stage.

E. aureliæ is well-known as an inhabitant of the mountains of Colombia.

149. *UROSTICTE BENJAMINI* Bourc.

Trochilus Benjamini Bourcier, Compt. Rend. Ac. Sci. Paris, xxxii. no. 6, Febr. p. 187. (1851—"les régions chauds des environs de Gualea," W. Ecuador).

No. —(♂) ad. La Selva, Rio Jamaraya, 4600 ft., Oct. 09.—Wing 52; tail 35; bill 23 mm.

Compared with specimens from Western Ecuador this bird has a decidedly longer bill and more white along the middle of the belly. From a single skin it is difficult to say whether these divergencies are of any importance.

Like ordinary *benjamini* the specimen from La Selva has a large lilac præpectoral spot.

So far as I am aware this is the first Colombian record of *U. benjamini*, although it is fairly common in Ecuador on both sides of the Andes.

150. *HELIANGELUS EXORTIS* Fras.

Trochilus exortis Fraser, P. Z. S. 1840, p. 14 (1840.—Guaduas, Colombia).

Heliotrypha parzudakii Selater & Salvin, P. Z. S. 1879, p. 529 (Santa Elena).

No. 2792. ♂ ad. Tatamá Mountain, 8000 ft., 12.x.09.—Wing 69; tail 49; bill 17 mm.

"Iris, feet, and bill black."

A common bird in the mountains of Colombia and northern Ecuador. Palmer's specimen agrees well with Bogotá skins.

151. *HELIOTHRIX BARROTI* Bourc. & Muls.

Trochilus Barroti Bourcier et Mulsant, Ann. Sci. phys. et nat., d'Agric. etc. Lyon, vi. p. 48 (1843.—"Carthagène," Colombia).

Heliothrix barroti Selater & Salvin, P. Z. S. 1879, p. 529 (Remedios).

No. 2198. ♂ ad. Noanama; 17.x.08.—Wing 66; tail 42; bill 16 mm.

No. 2329. ♂ juv. Nóvita; 23.xi.08.—Wing 65; tail 45; bill 15½ mm.

"Iris, feet, and bill black."

Not appreciably different from Costa Rican skins. *H. barroti*, which is very likely only a geographical race of *H. auritus*, ranges southwards as far as Western Ecuador.

152. *CYANOLESBIA KINGII*, subsp.

[*Ornismya kingii* Lesson, Hist. Nat. Trochil. p. 107, pl. 38 (1832. — "Jamaïque," errore — description and plate evidently apply to the common blue-tailed Bogotá form, with a large violet-blue gular patch)].

No. 3784. ♂ ad. Tatamá Mountain, 4600 ft. 7.x.09. — Wing 74; tail (slightly moulting) 93; bill 14 mm.

"Iris, feet, and bill black."

This bird cannot be identified with any of the known forms. It is somewhat intermediate between *C. k. kingii* from Bogotá, and *C. k. caelestis* * from Ecuador, though apparently different from either. With the latter, it shares the long, robust beak, the broad, rufous-buff edges to the under tail-coverts, and the bronzy-green general tone of the lower parts; but the rufescent margins to the feathers of the breast and abdomen are completely absent, and the colour of the tail is more like Bogotá specimens. It should be mentioned, however, that the under surface of the rectrices is much duller, more blackish than in any other example examined by me. More material will probably show the West Colombian birds to constitute a distinct race. Curiously enough, both Hartert †, and Simon & Dalmás ‡ record the green-tailed *C. k. emmae* Berl., without gular spot, from the Western Cordillera, while the Tatamá bird has the throat extensively violet-blue.

153. *CHLORONERPES RUBIGINOSUS GULARIS* Harg.

[*Picus rubiginosus* Swainson, Zool. Illustr. i. pl. xiv. (1820-1. — "Spanish Main," i. e. Venezuela, environs of Cumaná)].

Chloronerpes gularis Hargitt, Ibis, (6) i. p. 230. (1889. — Santa Elena, Antioquia).

C. rubiginosus (errore) Schater & Salvin, P. Z. S. 1879, p. 533 (Retiro, Concordia, Santa Elena).

No. 2798. ♂ ad. Loma Hermosa, Rio Jamaraya, 4150 ft., 18.x.09. — Wing 122; tail 84; bill $26\frac{1}{2}$ mm.

"Iris dark brown, feet plumbeous, bill black."

This bird agrees perfectly with Hargitt's description. It differs from *C. r. rubiginosus*, from N.E. Venezuela (Cumaná) and Trinidad, in having the rump and tail-coverts pale yellow in decided contrast to the deep tawny olive of the upper back, and the under parts more richly yellow with the blackish bars conspicuously narrower and confined to the foreneck and breast. The throat is much less variegated with whitish, and the feathers of the pileum, from the forehead to the nape, are tipped with crimson.

C. r. gularis is limited to Western Colombia, inhabiting both the Coast and the Central Cordillera.

* *Cyananthus caelestis* Gould, Introd. Humming-Birds p. 102 (1861. — Ecuador).

† Tierreich, Lief. 9, 1900, p. 176.

‡ Ornis, xi. 1901, p. 223 (Las Cruces, W. Cordillera).

154. MELANERPES PUCHERANI PUCHERANI Malh.

Zebrapicus pucherani Malherbe, Rev. Mag. Zool. (2) i. p. 542 (1849.—"Tabago," errore.*).

Nos. 2258, 2279. ♂ ♂ ad. Nóvita: 10, 13.xi.08.—Wing 115, 113; tail 67, 65; bill 26, 25 mm.

Nos. 1970, 2259. ♀ ♀ Guineo: 5.viii.; Nóvita: 10.xi.08.—Wing 108; tail 60, 62; bill 21 mm.

"Iris brown, feet grey or greyish green, bill black."

The series agrees with specimens from Western Ecuador.

M. p. pucherani ranges from Nicaragua southwards through Western Colombia to Guayaquil, S.W. Ecuador. Birds from Central America are perhaps slightly different, but I have not sufficient material to decide the question. The form occurring from Honduras north to S. Mexico has lately been separated as *M. p. perileucus* Todd †.

155. VENILIORNIS KIRKII CECILII Malh.

[*Picus (Chloropicus) Kirkii* Malherbe, Rev. Zool. viii. p. 400 (1845.—Tobago)].

Mesopicos Cecilii Malherbe, Rev. Mag. Zool. (2) i. p. 538 (1849.—Colombia).

Chloronerpes cecilie Sclater & Salvin, P. Z. S. 1879, p. 533 (Antioquia, Remedios, Neche).

No. 1986. (♂) ad. Guineo, Rio Calima: 10.viii.08.—Wing 84; tail 55; bill 20½ mm.

"Iris brown, feet pinkish grey, maxilla dark grey, mandible paler."

This bird, in abraded, bleached summer plumage, is not appreciably different from Bogotáskins. Specimens from Western Ecuador also agree well with the latter.

V. k. cecilii is peculiar to Colombia (Coast, Central and Eastern Cordillera ‡) and Western Ecuador. In Panama it is replaced by the doubtfully separable *V. k. darienensis* Ridgw. §

156. CELEUS LORICATUS Reichb.

Meiglyptes loricatus Reichenbach, Scansoriæ, p. 405, pl. dclxxxi. figs. 4495–96 (1854.—"Peru"; descr. ♀).

Celeus loricatus Sclater & Salvin, P. Z. S. 1879, p. 533 (Remedios & Neche).

* The species does not occur on "Tabago" (sc. Tobago), the original locality being no doubt erroneous. Later, in the *Monogr. des Picid.* ii. p. 227, Malherbesays that the specimens he saw in the British Museum came from "Tabago" while those existing in his own collection were from "Nouvelle-Grenade." We may therefore accept *Colombia* as the type locality since the birds from this country agree very well with Malherbe's description and figure (pl. ciii.).

† Proc. Biol. Soc. Wash. xxiii. p. 154 (1910.—Manatee, British Honduras).

‡ Count Berlepsch (J. f. Orn. 1884, p. 314: *Chloronerpes cecilie*) notices that examples from Bucaramanga are considerably larger than those from Bogotá.

§ Proc. Biol. Soc. Wash. xxiv. p. 33 (1911.—El Réal, Darien).

C. mentalis Cassin, Proc. Acad. N. Sci. Philad. 1860 p. 137 (1860.—Turbo & R. Atrato; descr. ♂).

No. 2254. (♂) ad. Nóvita: 9.xi.08.—Wing 117; tail 70; bill 21 mm.

"Iris crimson, feet grey, maxilla black, mandible yellow."

This specimen, a fully adult male with cheeks, malar region and upper throat crimson, corresponds exactly with Cassin's description of *C. mentalis*. The types of the latter were obtained in the same general region, but farther to the north, on the Rio Atrato.

It appears, however, that *M. loricatus* was based upon a female of the same species.

C. loricatus ranges from Costa Rica to Western Ecuador. I have not seen specimens from Costa Rica or Panama. If separable, they will have to bear the name *squamatus* Lawr. *

157. CEOPHLEUS LINEATUS LINEATUS Linn.

Picus lineatus Linnæus, Syst. Nat. 12, i. p. 174 (1766—*ex* Brisson: Cayana).

Dryocopus lineatus Sclater & Salvin, P. Z. S. 1879, p. 532 (Santa Elena).

No. 2014. ♀ ad. Noanama: 25.viii.08.—Wing 180; tail 115; bill 36 mm.

"Iris white, feet blue-grey, bill black."

[158. PICUMNUS OLIVACEUS GRANADENSIS Lafr.

[*Picumnus olivaceus* Lafresnaye, Rev. Zool. viii. p. 7 (1845—"ad. Bogotam, in Colombiâ").]

P. granadensis Lafresnaye, l. c. x. p. 78 (1847.—"ad. Caly, in Novâ Granadâ"—coll. Delattre: ♀ ad., type in Mus. Acad. Philad., *cfr.* Stone, Proc. Acad. N. Sci. Philad. li. 1899, p. 52); Hargitt, Cat. B. Brit. Mus. xviii. p. 549 (part.: *f, g.* ♂ ♀ Medellin, Antioquia, examined by me).

P. olivaceus (nec Lafr.) Sclater & Salvin, P. Z. S. 1879, p. 532 (Medellin, Colombia).

P. canus Bangs, Proc. Biol. Soc. Wash. xxiii. p. 72 (1910.—Naranjito, R. Dagua; one ♀ ad.).

No. 387. ♂ ad. Primavera, W. Colombia, 5200 ft. Raap coll.—Wing 60; tail 30; bill $13\frac{1}{3}$ mm.

No. 246. ♂ ad. San Isidro, 2700 ft. Raap coll.—Wing 59; tail 29; bill 12 mm.

Nos. 257, 271. ♀ ♀ ad.—Media Luna and Isidro, 2700 ft. Raap coll.—Wing 58, 59; tail 29, 30; bill 12 mm.

One ♀ ad. San Antonio, Western Cordillera, 5400 ft. 13.vi.09. Fassl coll.—Wing 57; tail 30; bill 12 mm.

Two ♂ ♂ ad. Rio Dagua: 12, 16.vi.95. Rosenberg coll.—Wing 58; tail $29\frac{1}{2}$, 30; bill 12–13 mm.

* *Celeus squamatus* Lawrence, Ibis, v. p. 184 (1863.—Panama Railroad).

This series, which belongs to the Tring Museum, enables us at last to make out the status of *P. granadensis*, originally based upon an adult female from the same district (Cali). I am sorry to say that Mr. Bangs under *P. canus* simply redescribed the true *granadensis*. This is quite evident on comparing the two descriptions, which agree almost word for word. In a note appended to the diagnosis of *P. o. harterti* *, I have already alluded to the distinguishing characters of *P. o. granadensis*, but a few additional remarks may not be out of place here. The geographical variation of this group was quite unsatisfactorily understood until Mr. Hartert † pointed out the differences existing between the three races then known to him. Hartert was, however, not acquainted with *granadensis* Lafr., for the birds from Western Ecuador to which he applied that name proved to be distinct and were subsequently separated by me as *P. o. harterti*.

According to our present knowledge, the following subspecies of *P. olivaceus* are easily recognizable:—

(a) *P. OLIVACEUS OLIVACEUS* Lafr.

Type from Bogotá.

Adult. Back warm greenish brown or olivaceous brown; chest strongly tinged with deep olivaceous; breast and abdomen yellowish with well-defined, though narrow, dusky stripes, particularly on the lower breast and flanks; quills edged with olivaceous. Adult males with tips to feathers of forehead “flame scarlet” (rather duller than pl. vii. fig. 14 of Ridgway’s Nomenclature).

Hab. Apparently the Eastern Cordillera of Colombia. All the specimens I have seen, eleven at Tring, and nine in the Munich Museum, are of the well-known Bogotá form.

(b) *P. OLIVACEUS FLAVOTINCTUS* Ridgw.‡

Type from Pozo Azul, Western Costa Rica.

Adult. Back not unlike *P. o. olivaceus*, but mostly somewhat darker; edges of remiges brighter and deeper olivaceous yellow; chest decidedly darker, more brownish, less greenish; dusky stripes of breast and abdomen wider and less sharply defined. Adult males with tips to feathers of forehead dull “cadmium orange” (Ridgw. Nomencl. pl. vi. fig. 2.)

Hab. South-western Costa Rica (south of Pozo Azul de Pirris) and Chiriqui §.

* Bull. B. O. C. xviii. March 1909, p. 67.

† Novit. Zool. ix. 1902, pp. 606-7.

‡ *P. flavotinctus* Ridgway, Proc. U. S. Mus. xi. 1888, p. 543 (1889.—Pozo Azul, W. Costa Rica).

§ An additional subspecies, *P. olivaceus panamensis* Ridgw. (Proc. Biol. Soc. Wash. xxiv. 1911, p. 34: Lion Hill Station, Panama) inhabits Panama (Lion Hill, Tocumé). There is a single adult male from the latter locality, obtained by E. André, in the Tring Museum. This form is nearest to *P. o. flavotinctus*, but has the chest buffy yellow (instead of brownish) and the back much paler, light earthy-brown.

Examined: Two males and two females, Costa Rica (Tring Museum), four males and one female, Chiriqui (Tring and Munich Museums).

N.B.—An adult male in bad condition, said to be from San Esteban, Venezuela, in the British Museum differs merely in having the breast more strongly tinged with brown. The locality is most probably erroneous.

(c) *P. OLIVACEUS HARTERTI* Hellm.

P. o. harterti Hellmayr, Bull. B.O.C. xxiii. p. 67 (March 1909.—Paramba, N.W. Ecuador).

P. granadensis (nec Lafr.) Sclater, P. Z. S. 1860, p. 95 (Nanegal); idem, l. c. p. 287 (Babahoyo); Berlepsch & Taczanowski, l. c. 1883, p. 570 (Chimbo, Yaguachi); idem, l. c. 1885, p. 106 (Yaguachi); Hartert, Nov. Zool. v. 1898, p. 497 (Chimbo); Salvadori & Festa, Boll. Mus. Zool. Torino, xv. no. 368, 1900, p. 16 (Vinces); Goodfellow, Ibis, 1902, p. 209 (Santo Domingo); Hargitt, Cat. B. Brit. Mus. xviii. p. 549 (part.: *i, k*, Babahoyo; *l*, Monji).

P. olivaceus granadensis Hartert, Nov. Zool. ix. 1902, p. 606 (Chimbo, Paramba, S. Domingo).

Type from Paramba, N.W. Ecuador, 3500 ft. alt.

Adult. Much like *P. o. flavotinctus*, but chest olivaceous as in *P. o. olivaceus*, and adult males with tips of feathers on forehead much paler, cadmium yellow (Ridgw. pl. vi. fig. 6).

Hab. Western Ecuador, from sea-level up to 3500 feet.

Examined: Eleven males and four females in British, Tring, and Munich Museums.

(d) *P. OLIVACEUS GRANADENSIS* Lafr.

Synonymy, see above.

Type from Cali, W. Colombia.

Adult. Differs at once from the three preceding races in having the back light olive-grey or pale smoky-grey (without greenish or brownish suffusion) and the under parts creamy-white, nearly uniform, with but a few obsolete dusky streaks on the flanks, and the foreneck very slightly tinged with dull greyish. Edges of the quills creamy white, instead of olivaceous or olive-yellow. Tips of feathers on forehead in adult males even paler than in *P. o. harterti*, "chrome-yellow" (Ridgw. pl. vi. fig. 8.)

Hab. Western Cordillera of Colombia. Cali (*Delattre*), Rio Dagua (*Rosenberg*), Naranjito (*Palmer*); Primavera, San Isidro, Media Luna (*Raap*); San Antonio (*Fassl*); Medellin, Antioquia (*Salmon*).

Obs. In addition to the specimens enumerated above I examined a couple from Medellin (*Salmon*) in the British Museum and found them to agree. One of the Dagua examples (*Rosenberg*) is rather more brownish grey above than the others, thereby forming the passage to *P. o. harterti*.

(e) *P. OLIVACEUS DIMOTUS* Bangs.

Picummus dimotus Bangs, Bull. Mus. Harvard Coll. xxxix. p. 146 (1903.—Ceiba, Honduras).

P. olivaceus (nec Lafr.) Hargitt, Cat. B. Brit. Mus. xviii. p. 548 (part.: *h, i*, Julian, S. Pedro: Honduras).

Adult. Much like *P. o. olivaceus*, and agreeing in the adult males in having the tips of the feathers on the forehead scarlet, but with back and chest much more greenish, and dusky streaks on belly less distinct.

Hab. Honduras: Ceiba, Julian, San Pedro; Nicaragua.

Examined: Two adult males from Honduras (*Whitely*) in the British Museum.]

159. *CERYLE TORQUATA TORQUATA* Linn.

Alcedo torquata Linnæus, Syst. Nat. 12, i. p. 180 (1766—*ex* Brisson: Mexico & Martinique).

Ceryle torquata Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 133 (R. Atrato & Truando); Selater & Salvin, P. Z. S. 1879, p. 534 (Neche).

No. 3759. ♀ ad. Siató, R. Siató, 5200 ft., 17.ix.09.—Wing 195; tail 122; bill 65 mm.

"Iris brown, feet greyish green, bill black, base yellow."

160. *CERYLE AMAZONA* Lath.

Alcedo amazona Latham, Ind. Ornith. i. p. 257 (1790.—"Cayana").

Ceryle amazona Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 133 (R. Nercua); Selater & Salvin, P. Z. S. 1879, p. 534 (Neche).

No. 2397. ♂ ad. Nóvita: 14.xii.08.—Wing 131; tail 85; bill 66 mm.

"Iris dark brown, feet and bill black."

161. *CERYLE INDA* Linn.

Alcedo inda Linnæus, Syst. Nat. 12, i. p. 179 (1766—*ex* Edwards: "India occid.", errore; we substitute *Surinam* as type locality).

Ceryle inda Cassin, l. c. p. 133 (Turbo).

No. 2723. ♀ ad. Tadó, R. San Juan: 28.ii.09.—Wing 97; tail 62; bill 43 mm.

"Iris dark brown, feet black, maxilla black mandible dark brown."

162. *CERYLE AMERICANA AMERICANA* Gm. (?)

Alcedo americana Gmelin, Syst. Nat. 1, i. p. 451 (1788—*ex* Daubenton, Pl. Enl. 591. figs. 1, 2: Cayenne).

Ceryle cabanisi (nec Tschudi) Selater & Salvin, P. Z. S. 1879, p. 534 (Retiro, Concordia, Medellín).

Nos. 1990, 2077, 2209. ♂♂ ad. Mouth of Calima: 13.viii.; Sipí: 11.ix.08; Noanama: 21.x.08.—Wing 75–77; tail 54–55; bill 36–39 mm.

"Iris dark brown, feet and bill black."

These three as well as another adult male from the Cauca River (Batty coll.) in the Munich Museum differ from a very large series of skins obtained in Cayenne, Venezuela (Caura), Brazil, etc., in having the under tail-coverts wholly unspotted white or very faintly spotted with bronze-green. It should be mentioned, however, that this character is likewise found in two specimens from the island of Tobago.

In the absence of typical examples from Western Peru, I cannot say whether the birds from Western Colombia should not be referred to *C. a. cabanisii* Tsch.* I notice, however, that the white bars on the quills are by no means broader than in typical *C. a. americana*, which is said to be the case in the Peruvian form.

163. TROGON MASSENA Gould.

Trogon massena Gould, Monogr. Trogon. 1st ed. pl. 16 (1838.—Guatemala); Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 135 (Truando; delta of the Atrato).

No. 2008. ♂ ad. Noanama, 100 ft., 26.viii.08.—Wing 170; tail 168; bill 24 mm.

"Iris dark brown, feet brownish yellow, bill orange-yellow."

Compared with others from Central America, this bird is smaller, and has the middle pair of rectrices washed with dull bluish instead of clear bronze-green. With a single specimen at hand it is, of course, impossible to judge the value of these variations. In other respects the male from Noanama is a typical *massena*, there being not the least trace of a white breast-band, etc.

Noanama is the most southerly locality yet known for *T. massena*. Curiously enough, the late T. K. Salmon obtained the nearly allied *T. melanurus macrourus* Gould in the State of Antioquia †, provided that his specimens have been correctly determined.

164. UROSPATHA MARTII SEMIRUFA ScL.

[*Prionites martii* Spix, Av. Bras. i. p. 64, pl. lx. (1824—"in sylvis Parae").]

Momotus semirufa ScLATER, Rev. Mag. Zool. (2) v. p. 489 (1853—part.: Santa Marta, New Grenada ‡).

Momotus Martii (nec Spix) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 136 (River Nercua).

Urospatha martii ScLATER & SALVIN, P. Z. S. 1879, p. 534 (Remedios, Neche).

* *Alcedo Cabanisii* Tschudi, Fauna Peru., Aves, p. 253 (1844-45.—"environs of Lima").

† *T. macrurus* ScLATER & SALVIN, P. Z. S. 1879, p. 535 (Remedios, Neche).

‡ Although one of the localities, Rio Javarri (W. Brazil), refers to typical *U. m. martii*, ScLATER's description is evidently taken from the Santa Marta specimen. Cfr. the words: "cauda spatulata."

Nos. 2108, 2419. ♂ ♂ ad. Sipi: 23.ix.; Nóvita: 20.xii.08.—Wing 147, 150; tail 250, 255; bill 45, 47 mm.

No. 2013. ♀ ad. Noanama: 25.viii.08.—Wing 148; tail 250; bill 46 mm.

"Iris dark brown, feet and bill black."

All three specimens have the median rectrices spatulated and decidedly bluish. *Cfr.* also my remarks in Abhandl. Bayer. Akad. Wiss., II. Cl. vol. xxii. 3, 1906, p. 611, and in Nov. Zool. xiv. 1907, p. 403.

U. martii semirufa replaces the typical race in Western Ecuador and Colombia, ranging northwards to Costa Rica and Nicaragua.

165. MOMOTUS ÆQUATORIALIS ÆQUATORIALIS Gould.

Momotus æquatorialis Gould, P. Z. S. 1857, p. 223 (Jan. 1858.—"Archidona, near the Equatorial line, on a branch of the Rio Napo"); Sclater & Salvin, P. Z. S. 1879, p. 534 (Envigado, Retiro, Concordia, Frontino).

No. 2820. ♂ ad. Pueblo Rico, 5200 ft., 29.x.09.—Wing 154; tail 315; bill 42½ mm.

"Iris vermilion, feet dark grey, bill black."

We have also a fine pair procured by the late J. H. Batty at Rio Lima, 4500 feet, Western Cordillera, in August 1898. The Colombian skins agree exactly with others from Ambato, E. Ecuador, which can be regarded as topotypical.

M. æquatorialis is an inhabitant of the highlands of Ecuador and Western Colombia. It may prove to be merely the southern form of the Central American *M. lessoni* Less. In Peru it is replaced by a nearly allied race, *M. æquatorialis chlorolaemus* Berl. & Stolz.*

166. GALBULA MELANOGENIA Scl.

Galbula melanogenia Sclater, Contrib. to Ornith. for 1852, p. 61 (1852—loc. ign.).

G. ruficauda (nec Cuvier) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 134 (River Nercua).

Nos. 2219, 2513. ♂ ♂ ad. Rio Cajón, 125 ft., 29.x.08; El Tigre, 320 ft., 5.ii.09.—Wing 79, 82; tail 93, 94; bill 47 mm.

Nos. 2220, 2567. ♀ ♀ ad. Rio Cajón: 29.x.08; Juntas, 400 ft., 11.iii.09.—Wing 79, 81; tail 93; bill 44 mm.

"Iris dark brown, feet yellowish green, bill black."

The specimens are identical with others from Chiriqui and Western Ecuador.

167. BUCCO PECTORALIS Gray.

Bucco pectoralis Gray, Genera Birds, i. pl. xxvi. (Dec. 1846—no locality given); Wyatt, Ibis, 1871, p. 374 (Magdalena Valley, between Naranjo and the river); Sclater & Salvin, P. Z. S. 1879,

* P. Z. S. 1902, ii. p. 35 (1902.—Ocobamba near Cuzco, S.E. Peru).

p. 536 (Neche); Berlepsch, Journ. f. Ornith. 1884, p. 315 (Bucaramanga).

Nos. 2464, 2626. ♂ ad., ♂ imm. Nóvita: 4.xii.08; Tadó: 29.iv.09.—Wing 100; tail 83; bill $32\frac{1}{2}$, 32 mm.

Nos. 2318, 2359, 2464. ♀ ♀ ad., 1 ♀ imm. Nóvita: 20.xi., 1.xii.08; Noanama: 12.i.09.—Wing 95–100; tail 80–84; bill 30–33 mm.

“Iris dark red, feet grey, bill black.”

Adults have the edges of the scapulars, wing-coverts, rump, etc., pure white, while they are more or less tinged with buff in immature birds; the latter also show a slight buffish wash on the lower flanks and under tail-coverts.

Two skins from Chiriqui have the black portions of the plumage faintly glossed with oil-green, while our Chocó series, as also a couple from N.W. Ecuador, show a strong metallic blue gloss.

B. pectoralis ranges from Western Panama (Chiriqui) southwards to N.W. Ecuador (province Esmeraldas*). It is exclusively found in the hot, dense forests of the lowlands.

168. *BUCCO TECTUS SUBTECTUS* Sel.

[*Bucco tectus* Boddaert, Tabl. Pl. Enl. p. 43 (1783—*ex* Daubenton, Pl. Enl. 688. fig. 2: Cayenne).]

Bucco subtectus Selater, P.Z.S. 1860, p. 296 (1860.—Esmeraldas, N.W. Ecuador); Selater & Salvin, P.Z.S. 1879, p. 536 (Neche).

Nos. 2634, 2703. ♀ ♀ ad. Tadó (230 ft.): 3.v., 12.vi.08.—Wing 69; tail 56; bill 21, 22 mm.

“Iris red, feet and bill black.”

This well-characterized race differs from *B. t. tectus*, of Cayenne, Pará, and Eastern Venezuela (Caura), in several important points: The upper parts are of a much deeper, more glossy black; the white spots on the head are confined to the forehead and anterior crown; the white cross-bar on the inner web of the submedian pair of rectrices is either wholly absent or but faintly indicated; the black crescent of the foreneck is much narrower; the bill more slender.

Birds from Panama have even less white spotting about the forehead than those from more southern localities, but otherwise they do not differ.

B. t. subtectus has exactly the same range as the preceding species, occurring from Western Panama (Chiriqui) south to N.W. Ecuador (province Esmeraldas).

169. *BUCCO NOANAMÆ* Hellm.

Bucco noanamæ Hellmayr, Bull. B. O. C. xxv. p. 21 (1909.—Noanama, W. Colombia).

* There are two specimens in the Tring Museum: ♂ ad. from Carondelet (60 ft.), Oct. 16, 1900; ♀ ad. Bulón (160 ft.), Dec. 23, 1900, both secured by Mr. G. Flemming, one of Mr. Rosenberg's correspondents.

No. 2033. ♂ ad. Noanama (100 ft.), 28.viii.08. *Type of species*.—Wing 81; tail 66; bill 28 mm.

Nos. 2703, 2711. ♂ ♀ ad. Tadó (230 ft.), 8, 16.vi.09.—Wing 81, 80; tail 66; bill 28, 27 mm.

"Iris red or brown, feet grey, bill black."

Adult (sexes alike). Upper part of the head and nape dark ashy; back and upper wing-coverts dark sepia-brown, each feather with a distinct, pale rufescent apical margin; upper tail-coverts with rather brighter rufescent cross-bands and edges; remiges and rectrices dusky, narrowly fringed with rufescent-buff along the outer web. Narrow frontal edge and broad superciliaries, reaching as far as the posterior angle of the eye, soiled white; lores ashy black; cheeks, ear-coverts, and sides of the neck dark ashy, some of the feathers edged with pale greyish. Malar region, chin, and throat white; chest dull sooty black, most of the feathers showing, on their concealed basal portion, a white mesial spot or streak, only to be seen when the feathers are raised; rest of the belly white, washed with ochreous-buff and marked with coarse blackish spots or transverse bands; under tail-coverts uniform buff. Axillaries and under wing-coverts deep buff, mixed with blackish; inner web of remiges broadly edged with buff on its basal half.

This new Puff-bird is not very nearly related to any other member of the genus. In proportions and style of coloration (such as the rufescent cross-bands on the upper parts, buff axillaries, under wing-coverts and quill-lining, etc.) it is not unlike *B. macrodactylus* Spix from Amazonia; but the ashy cap, the much broader blackish breast-band, the coarse spotting of the belly, etc., as well as the much larger size, serve to distinguish it at a glance.

The three specimens sent by Mr. Palmer are perfectly alike, the female being but very slightly smaller.

B. noanamae is, as yet, known only from the valley of the San Juan River in Western Colombia.

170. MALACOPTILA PANAMENSIS POLIOPIS Sci.

[*Malacoptila Panamensis* Lafresnaye, Rev. Zool. x. p. 79 (1847.—Panama).]

Malacoptila poliopis Scater, P. Z. S. 1862, p. 86, pl. viii. (1862.—Esmeraldas, N.W. Ecuador, descr. ♀).

M. panamensis (nec Lafr.) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 134 (Rio Truando).

Nos. 2085, 2437, 2520. ♂ ♂ ad. Sipi (150 ft.), 12.ix.; Nóvita (150 ft.), 26.xii.08; El Tigre (320 ft.), 9.ii.09.—Wing 88-90; tail 75-78; bill 29 mm.

Nos. 2084, 2593. ♀ ♀ ad. Sipi (150 ft.), 12.ix.08; Condoto (150 ft.), 12.iv.09.—Wing 86-88; tail 75, 79; bill 29 mm.

"Iris red, feet grey, maxilla black, mandible yellowish grey."

The series agrees perfectly with topotypical examples from the

province of Esmeraldas. *M. p. poliopis* appears to be a well-marked race, differing from *M. p. panamensis*, of Panama, Chiriquí, and S.W. Costa Rica, in its darker coloration. The males are much darker rufous above and have the throat and foreneck of a deeper cinnamon-rufous shade, whilst the females may also be distinguished by their fuscous (less brownish) back, more blackish cheeks, darker ochraceous foreneck, etc.

M. p. poliopis is apparently confined to the lowlands and foothills of the Pacific coast district of Colombia (from the Truando southwards) and W. Ecuador (south to Guayaquil).

171. *MALACOPTILA MYSTACALIS* Lafr.

Monasa mystacalis Lafresnaye, Rev. Mag. Zool. (2) ii. p. 215 (1850.—Colombiá).

Malacoptila panamensis (errore) Selater & Salvin, P. Z. S. 1879, p. 536 (Remedios).

M. mystacalis Berlepsch, Journ. f. Ornith. 1884, p. 315 (Bucaramanga; crit.).

Nos. 2803, 3764. ♂ ♀ ad. Loma Hermosa (4150 ft.), 22.x.; Siató, near Pueblo Rico (5200 ft.), 21.ix.09.—Wing 98, 95; tail 96, 94; bill 30, 28 mm.

"Iris red, feet grey, maxilla black, mandible yellow."

These two specimens as well as several others from Bogotá are undoubtedly different from *M. p. poliopis*. They are much larger, with a stouter, stronger bill; the forehead is broadly white, bordered posteriorly by a very distinct, black band; the cinnamon-rufous colour below extends down over the breast, leaving only the middle of the abdomen white, the flanks being mixed with dull earthy brown, while in all the races of *M. panamensis* the breast and sides are sharply striped with blackish; the upper parts are of quite another shade of brown, etc. The sexes are alike, whereas there is a marked sexual difference in the forms of *M. panamensis*.

M. mystacalis inhabits the mountains of Colombia, being found in the Western as well as in the Eastern Cordillera (Bucaramanga, Bogotá).

172. *MONASA PALLESCENS* Cass.

Monasa pallescens Cassin, Proc. Ac. N. Sci. Philad. 1860, p. 134 (1860.—Cordilleras of the Rio Truando); idem, l. c. 1864, p. 287, pl. iv.; Wyatt, Ibis, 1871, p. 374 (Paturia, Magdalena Valley); Selater & Salvin, P. Z. S. 1879, p. 536 (Remedios, Neche).

No. 2562. ♀ ad. Juntas, Rio Tamana (405 ft.), 5.iii.09.—Wing 142; tail 132; bill 39 mm.

"Iris dark brown, feet black, bill scarlet."

A fine example of this scarce species, which is at once known, among the other white-fronted forms, by its black throat and smaller, nearly white upper wing-coverts. It corresponds exactly with Cassin's description and figure.

M. pallescens is peculiar to the forests of Western Colombia, Juntas being the most southerly locality on record. Specimens from the Central Cordillera (Remedios, Neche, Paturia) I have not seen, but from Sclater's remarks they would seem to be somewhat different.

173. *CAPITO QUINTICOLOR* Elliot.

Capito quinticolor Elliot, Nouv. Arch. Mus. Paris, i. Bull. p. 76, pl. iv. fig. 1 (1865.—"Nouvelle Grenade," Triana coll.); Dalmas, Bull. Soc. Zool. France, xxv. 1900, p. 176 (♂ ♀: El Paillon, near Buenaventura).

No. 2689. ♂ ad. Tadó, 230 ft., 2.vi.09.—Wing 82; tail $45\frac{1}{2}$; bill 21 mm.

"Irides reddish brown, feet dark grey, maxilla black, mandible blue-grey."

This bird agrees well with the figure of the type except in having a distinct orange tinge along the middle of the lower breast and abdomen. It is an adult male in perfect plumage. *C. quinticolor* is the rarest of the Barbets of South America, only four specimens being on record. The type, in the Paris Museum, was brought by Mons. Triana from Colombia, without any further locality. Count Dalmas recorded a couple obtained by Eugène André near Buenaventura, province of Chocó, viz., in the same general district whence our specimen also comes.

C. quinticolor is apparently confined to the humid, forest-covered lowlands of Western Colombia.

174. *CAPITO MACULICORONATUS* Lawr.

Capito maculicoronatus Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 300 (Jan. 1861.—Lion Hill, Panama); Sclater & Salvin, P. Z. S. 1879, p. 537 (Remedios, Neche: Antioquia).

Nos. 2297, 2312. ♂ ♂ ad. Nóvita: 16, 19.xi.08.—Wing 88, 85; tail 56, 54; bill $21\frac{1}{2}$ mm.

No. 2227. ♂ nearly ad. Rio Cajón: 31.x.08.—Wing 85; tail 56; bill 22 mm.

Nos. 2298, 2313. ♀ ♀ ad. Nóvita: 16, 19.xi.08.—Wing 84; tail 53, 54; bill $21\frac{1}{2}$, 22 mm.

No. 2028. ♀ imm. Noanama: 28.viii.08.—Wing 78; tail 54; bill 21 mm.

"Iris black (♂), dark brown (♀), feet blue, bill blue, tip black."

Compared with two specimens from Panama in the Munich Museum, the males have the yellow tinge across the lower breast rather paler, but in other respects they are similar.

C. maculicoronatus ranges from Veragua and Panama southwards to Western Colombia, and inhabits exclusively the hot, forest-clad lowlands and foot-hills.

In Western Ecuador, its place is taken by *C. squamatus* Salv.*, which differs, in both sexes, in lacking the scarlet patch on the flanks, in possessing a large white patch on the outer web of the tertiaries, and in having the forehead orange-red instead of black. The female, too, has the feathers of the back and the upper wing-coverts narrowly edged with white. The hitherto undescribed male has—like that of *C. maculicoronatus*—the cheeks, throat and foreneck white, the chest light saffron-yellow, and the upper parts uniform glossy black, but there are hardly any black streaks on the flanks. I have examined a good series from Carondelet (province Esmeraldas) and Santo Domingo, W. Ecuador.

175. *CAPITO BOURCIERII* SALVINI Shelley.

[*Micropogon Bourcierii* Lafresnaye, Rev. Zool. viii. p. 179 (1845—ad Bogotam; descr. ♂).]

Capito salvini Shelley, Cat. B. Brit. Mus. xix. p. 119 (1891.—“Central America, from Panama to Costa Rica,” no type specified!); Dalmas, Bull. Soc. Zool. France, xxv. 1900, p. 180, note (Las Cruces, Western Cordillera above Buenaventura, 6000 ft.).

C. bourcieri (nec Lafresnaye) Sclater & Salvin, P.Z.S. 1879, p. 538 (Frontino, Antioquia).

No. 2806. ♂ ad. Loma Hermosa, Rio Jamaraya, 4150 ft., 23.x.09.—Wing 74; tail 52; bill 20 mm.

Nos. 2738, 2810. ♂ ♂ ad. Pueblo Rico, 5200 ft.: 7.ix., 25.x.09.—Wing 76, 73; tail 52; bill 20, 19½ mm.

Nos. 2739, —. ♀ ad., ♀ imm. Pueblo Rico: 7.ix., Nov. 09.—Wing 74; tail 50, 51; bill 20, 19 mm.

Nos. 2808, 3774. ♀ ♀ ad. Loma Hermosa: 23.x.09; Siató, 5200 ft., 25.ix.09.—Wing 71; tail 49, 47; bill 19 mm.

“Iris dark red, feet greyish green (♂) or blue-grey (♀), bill greenish yellow or yellow.”

As already pointed out by Count Dalmas (*l.c.*) the birds from W. Colombia are referable to *C. b. salvini*. Compared with a good number from Costa Rica and Chiriqui the specimens from Chocó are slightly larger on the average, but in coloration they are nearly similar. The males have the throat dark crimson which gradually passes into the deep orange of the chest, while, in the females, the broad black frontal band is immediately followed by the golden olive of the crown, without the least trace of the pale blue cross-band, so conspicuous a feature in *C. b. bourcierii* ♀, of the Eastern Cordillera (Bogotá).

Count Dalmas (*l.c.* pp. 179–180) most correctly explained the distinguishing characters of the three races of this group, and I quite agree with him that the West Ecuadorian birds constitute

* Ibis, 1876, p. 494, pl. xiv. (= ♀; Santa Rita); Goodfellow, Ibis, 1902, p. 218 (Santo Domingo).

a quite distinct form, immediately recognizable by the crimson of the throat and foreneck being abruptly contrasted with the clear sulphur-yellow belly without any orange tinge. His name *C. shelleyi** is, however, antedated by *C. æquatorialis* Salvad. & Festa† by several months. Of this distinct form I have examined, besides the type actually at Tring, two fine adult males from Quito and Gualea, in the Munich Museum, and two males in poor condition, from Nanegal and Esmeraldas, respectively, in the British Museum collection. The original locality "Rio Napo" is erroneous, the type being a skin of the well-known Quito form.

The range of the three races known to me is as follows:—

- (a) *C. b. bourcierii* Lafr. Eastern Cordillera of Colombia (Bogotá coll.), and Eastern Ecuador.
- (b) *C. b. salvini* Shelley. Costa Rica, Chiriqui and Western Cordillera of Colombia.
- (c) *C. b. æquatorialis* Salvad. & Festa. Western Ecuador: Intac, Chimbo, Pallatanga, Nanegal, Esmeraldas, etc.

[176. SEMNORNIS RAMPHASTINUS Jard.

Tetragonops ramphastinus Jardine, New Edinburgh Philos. Journ. (n. s.) ii. p. 404 (Oct. 1855.—"Eastern Cordillera between Quito and the mountain Cayambe," N. Ecuador).

No. 87. ♂ ad. La Tigra, W. Cordillera, 5700 ft., 13.iv., 1899. E. André coll.—Wing 110; tail 81; bill 22 mm.

"Iris red, feet olive-yellow, bill yellow, with a dusky spot towards the tip."

This bird agrees perfectly with specimens in the Munich Museum from the neighbourhood of Quito.

So far as I know the species has not previously been recorded from Colombia.]

177. RAMPHASTOS SWAINSONII Gould.

Rhamphastos Swainsonii Gould, P. Z. S. 1833, p. 69 (Sept. 1833—"in montosis Columbiæ.")

Ramphastos tocard (nec Vieillot) Sclater & Salvin, P. Z. S. 1879, p. 537 (Concordia, Medellín, Remedios).

R. tocardus Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 136 (River Nercua).

No. 2000. ♀ ad. Noanama (100 ft.), 22.viii.08.—Wing 230; tail 170; bill 166 mm.

"Iris dark green; feet blue; base of maxilla below blackish, diagonal line dark red, remainder yellow; mandible dark red, apical third black with an oblong yellow patch near the tip."

This bird is typical *swainsonii*, having the basal portion of both mandibles (in skin) rich salmon colour, while in the allied

* Bull. Soc. Zool. France, xxv. p. 179 (Nov. 1900.—"Rio Napo"—errore!)

† Boll. Mus. Zool. Torino, xv. no. 368, p. 22 (Feb. 1900.—Intac, W. Ecuador).

R. ambiguus Swains.* the same parts are dull black. Cfr. Hartert's observations in Nov. Zool. v. 1898, p. 498.

I am at a loss to understand how the name *R. tocard* Vieill.† could have ever been applied to the present species. Levaillant's figure represents a bird with white throat and chest, and crimson upper tail-coverts, whereas *R. swainsonii* has the latter pure white and the throat deep yellow. The next available name is the one used above.

R. swainsonii (*tocard* auct.) ranges from southern Central America through Colombia to Western Ecuador.

178. PTEROGLOSSUS ERYTHROPYGIUS SANGUINEUS Gould.

[*Pteroglossus erythropygius* Gould, P. Z. S. 1843, p. 15 (July 1843.—Voyage of the 'Sulphur'; the type locality, later given as Realejo, Nicaragua, is doubtless erroneous).]

P. sanguineus Gould, Monogr. Ramph., 2nd edit., text to pl. 21 (1854—loc. ign.); Cassin, Proc. Acad. N. Sci. Philad. 1867, p. 109 (R. Truando, N. Colombia); Hartert, Nov. Zool. v. 1898, p. 498 (Cachabi, Paramba, N.W. Ecuador).

P. erythropygius (nec Gould) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 136 (R. Truando).

No. 2022. ♂ ad. Noanama: 27.viii.08.—Wing 151; tail 175; bill (measured with chord) 130 mm.

Nos. 2023, 2024, 2163, 2189. ♀ ♀ ad. Noanama: 27.viii.08; Sipi: 6,14.x.08.—Wing 147–152; tail 170–182; bill 112–120 mm.

"Iris yellow; feet greyish green; maxilla greyish yellow, tip yellow, broad culminal band and streak along cutting-edge black; mandible black."

The series proves beyond doubt that *P. e. sanguineus* is a perfectly valid form, the coloration of the bill being quite constant in all five specimens. I have also examined ten skins from various localities in N.W. Ecuador, belonging partly to the Tring and partly to the Munich Museums.

These fifteen examples invariably have the lower mandible black, while the maxilla, in addition to the black stripe along the cutting-edge, shows a broad, black culminal stripe, extending over more than the two basal thirds of its length. Cassin (*l. c.* pp. 109–110) gives the same coloration for six specimens obtained on the River Truando by Lieutenant Michler's Expedition. Sometimes the extreme base of the mandible is slightly clouded or marbled with dull greyish yellow, and a small spot at the extreme tip is soiled yellowish.

In *P. e. erythropygius* Gould, on the other hand, the bill is pale yellow except a black stripe along the cutting-edges of the maxilla, and a slight dusky tip to the lower mandible. The culminal stripe is generally absent, though occasionally specimens

* Zool. Illustr. iii. pl. 168 (no locality).

† Nouv. Dict. xxxiv. p. 281 (1819—based on Levaillant, Ois. de Paradis, etc., ii. pl. 9).

may be found with an indistinct, narrow streak down the centre of the culmen.

P. e. sanguineus inhabits the lowlands and hill-ranges of Western Colombia (from the Truando southwards) and N.W. Ecuador (province Esmeraldas : Cachabi, Paramba, Bulún, etc.)*.

P. e. erythropygius replaces it in the more southern districts of Western Ecuador : Babahoyo, Pallatanga, Chimbo, Rio Peripa, Santa Rita, Santo Domingo, etc. The Tring and Munich Museums possess good series of this form, showing its characters to be quite constant †.

179. *COCYZUS MELACORYPHUS* Vieill.

Coccyzus melacoryphus Vieill. Nouv. Dict. viii. p. 271 (1817—*ex* Azara : Paraguay).

No. 2104. ♂ ad. Sipi : 22.ix.08.—Wing 110 ; tail 128 ; bill 25 mm.

"Iris black, feet grey, bill black."

Rather small, but not otherwise different from Brazilian examples.

180. *PIONOPSITTA PULCHRA* Berl.

Pionopsitta pulchra Berlepsch, Ornith. Monatsber. v. p. 175 (1897.—San José, Rio Dagua, W. Colombia) ; Hartert, Nov. Zool. v. 1898, p. 500 (Cachabi, N.W. Ecuador).

No. 2016. ♀ ad. Noanama : 26.viii.08.—Wing 146 ; tail 64 ; bill (with chord) 22 mm.

"Iris blue-grey, feet dirty yellow, bill white."

A fine specimen of this rare Parrot, which was discovered on the Rio Dagua by the late Gustav Hopke, and was afterwards met with by Mr. Rosenberg near Cachabi, in the Ecuadorian province of Esmeraldas.

The species is evidently restricted to the hot lowlands of W. Colombia and N.W. Ecuador. It is allied to, but quite distinct from, the Central American *P. hæmatotis* Sel. & Salv.

181. *PIONUS MENSTRUUS* Linn.

Psittacus menstruus Linnaeus, Syst. Nat. 12, i. p. 148 (1766—*ex* Edwards—hab. ign.—et Brisson : "Guiane," *sc.* Cayenne).

Pionus menstruus Sclater & Salvin, P. Z. S. 1879, p. 538 (Remedios).

Nos. 2010, 2168, 2169. ♂ ♂ ♀ ad. Noanama : 25.viii. ; Rio Garrapatas : 8.x.08.—Wing 180–175 ; tail 75–80 ; bill 27–28 mm.

* Lawrence's record of *P. erythropygius* from Chiriqui (Ann. Lyc. N. H. N. Y. viii. 1865, p. 178) is certainly referable to some other species, perhaps *P. torquatus*, of which the Munich Museum has a large series from Boquete.

† Salvadori & Festa (Boll. Mus. Zool. Torino, xv. no. 368, 1900, p. 23) describe a "young" bird of *P. erythropygius* (from Intac) as having the lower mandible and a distinct culminal stripe black. I cannot help thinking that the specimen in question really belongs to *P. e. sanguineus*, though its occurrence so far south would be remarkable.

"Iris brown, feet whitish, maxilla black with base red, mandible black."

Colombian examples of this wide-spread species are apparently not different from others taken in Cayenne, Brazil, and Venezuela. There is perhaps generally more rosy suffusion on the foreneck, though this is not quite constant.

182. *MICRASTUR GUERILLA INTERSTES* Bangs.

[*Micrastur guerilla* Cassin, Proc. Acad. N. Sci. Philad. iv. p. 87 (1848.—Jalapa, Mexico).]

Micrastur interstes Bangs, Auk, xxiv. p. 289 (1907.—La Estrella, Cartago, Costa Rica).

No. 2330. ♀ ad. Nóvita, Río Tamaná (150 ft.), 24.xi.08.—Wing 175; tail 165; bill (from cere measured with chord) 18 mm.

"Iris and feet yellow, bill black."

This specimen, a perfectly adult bird in the "plumbeous phase," except in being slightly larger, agrees with an adult from Miramar (Chiriqui) and a couple from Cartago, Costa Rica (*Underwood*). All the under surface, from the foreneck to the tail-coverts, is closely barred black and white, as described by Mr. Bangs. The sides of the head and the throat are pale smoky grey (the former somewhat darker than the latter), exactly as in the Central American skins; but the scapulars and, to a lesser degree, the wings are more strongly tinged with chocolate-brown.

M. g. zonothorax Cab.* from Venezuela, of which I have examined six specimens procured in the mountains around Merida, differs from the Colombian and Costa Rican birds in having the sides of the head and the throat dull rufescent brown, and the quills more or less rufous-brown. Moreover, the mantle is generally washed with chocolate-brown, whereby its close relation to *M. ruficollis* Vieill. is supported. That *zonothorax* is merely a race of *M. guerilla* is clearly shown by a specimen from Paramba, N.W. Ecuador, in the Tring Museum, which combines the dull rufescent brown cheeks and throat with the blackish wings.

M. g. interstes ranges from Costa Rica and Chiriqui southwards to Western Ecuador (Nanegal, Paramba, Surupata, etc.).

183. *ACCIPITER SUPERCILIOSUS* Linn.

Falco superciliosus Linnæus, Syst. Nat. 12, i. p. 128 (1766.—Surinam: juv.).

Accipiter tinus Sclater & Salvin, P. Z. S. 1879, p. 541 (Remedios).

No. 2628. ♀ imm. Tadó (230 ft.), 30.iv.09.—Wing 149; tail 105; bill 13 mm.

"Iris orange, feet yellow, bill black, base yellow."

* *Climacocercus zonothorax* Cabanis, Journ. f. Orn. xiii. p. 406 (1865.—Puerto Cabello, N. Venezuela).

184. *LEUCOPTERNIS PLUMBEA* Salv.

Leucopternis plumbea Salvin, Ibis (3) ii. p. 240, pl. viii. (1872.—Ecuador); Hartert, Nov. Zool. ix. 1902, p. 605 (Paramba, S. Javier, N.W. Ecuador).

No. 2103. ♂ ad. Sipi, 150 ft., 22.ix.08.—Wing 220; tail 130; bill 24 mm.

"Iris crimson, feet orange-red, bill black, base orange."

This bird corresponds with Salvin's description and figure with the exception that the thighs are but obsoletely barred with white. The other characteristics, viz. the white under wing-coverts and quill-lining, and the broad white bar across the middle of the tail, are very well pronounced.

L. plumbea, although nearly allied to *L. schistacea* Sund,* of Amazonia, may easily be distinguished by its much smaller size, by lacking the white apical band to the rectrices, etc., etc. It was hitherto known only as an inhabitant of Western Ecuador†, and is very rare in collections.

185. *LEUCOPTERNIS SEMIPLUMBEA* Lawr.

Leucopternis semiplumbeus Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 288 (1861.—Panama Railroad).

L. semiplumbea Scater & Salvin, P. Z. S. 1879, p. 540 (Remedios); Hartert, Nov. Zool. ix. 1902, p. 605 (Paramba, S. Javier, N.W. Ecuador).

No. 2566. ♀ ad. Juntas, R. Tamana (405 ft.), 10.iii.09.—Wing 188; tail 130; bill 22 mm.

"Iris yellow, feet orange, maxilla black, base orange, mandible yellow."

The skin is in every respect typical. *L. semiplumbea* ranges from Nicaragua and Costa Rica through Western Colombia to the province of Esmeraldas, N.W. Ecuador.

186. *HERPOTOTHERES CACHINNANS* Linn.

Falco cachinnans Linnæus, Syst. Nat. x. p. 90 (1758—ex Rolander: "America meridionalis," hab. subst. Surinam, auct. Berlepsch, Nov. Zool. xv. p. 290).

Herpotheres cachinnans Scater & Salvin, P. Z. S. 1879, p. 541 (Cauca, Remedios).

No. 2367. ♂ ad. Növita (150 ft.), 4.xii.08.—Wing 250; tail 195; bill 26 mm.

"Iris brown, feet yellow, bill black, base yellow."

187. *LEPTODON PALLIATUS* Temm.

Falco palliatus (Wied MS.) Temminck, Pl. Col. livr. 23, pl. 204 (1823.—"Brésil et Guiane"; juv.).

* *Asturina schistacea* Sundevall, Öfvers. Vetensk.-Akad. Forhandl. vii. No. 5, p. 132, note 3 (1850.—"Brasilia").

† Sharpe's (Cat. B. i. p. 216) record from "Panama" requires confirmation.

Leptodon cayennensis auct. *

No. 2721. ♀ ad. Tadó (230 ft.), 26.vi.09.—Wing 270 ; tail 170 bill 29 mm.

"Iris dark grey, feet blue, maxilla black, mandible dark blue."

An adult bird of this wide-spread species.

188. *COLUMBA SPECTIOSA* Gm.

Columba speciosa Gmelin, Syst. Nat. 1, ii. p. 783 (1789—*e* Daubenton, Pl. Enl. 213 : Cayenne) ; Selater & Salvin, P. Z. S. 1879, p. 543 (Remedios).

No. 2476. ♂ vix ad. Noanama: 14.i.09.—Wing 187 ; tail 112 ; bill 20½ mm.

"Iris and feet dark red, bill scarlet."

A wide-ranging species.

189. *COLUMBA ALBILINEA ALBILINEA* Bonap.

Columba albilinea (*ex* Gray MS.) Bonaparte, Consp. Av. ii. p. 51 (Nov. 1854.—"Nova Granada").

C. albilineata Selater & Salvin, P. Z. S. 1879, p. 543 (Retiro).

No. 2801. ♂ ad. Loma Hermosa, 4150 ft., 19.x.09.—Wing 195 ; tail 140 ; bill 19½ mm.

"Iris light brown, feet and bill lemon-yellow."

This bird is exactly like specimens from Ecuador. North of the Isthmus of Panama *C. a. albilinea* is represented by the nearly allied *C. albilinea crissalis* Salvad. †, which has the underparts much paler and the top of the head more reddish.

190. *COLUMBA GOODSONI* Hart.

Columba goodsoni Hartert, Bull. B. O. C. xii. p. 42 (1902.—S. Javier, Pambilár, and Carondelet, N.W. Ecuador) ; idem, Nov. Zool. ix. 1902, p. 602 (Pambilár, S. Javier, Carondelet, Rio Sapayo ‡, Cayapas, N.W. Ecuador).

No. 2041. ♂ ad. Noanama (100 ft.), 31.viii.08.—Wing 150 ; tail 113 ; bill 14 mm.

"Iris pink, feet crimson, bill black."

This specimen, a male in full plumage, agrees perfectly with two topotypes from N.W. Ecuador. As pointed out by Hartert, the species is a very distinct one and may be distinguished from *C. nigrirostris brunneicauda* Carriker §, of Costa Rica and Panama, in having the top and sides of the head clear plumbeous grey and

* The specific name *cayennensis* cannot be used for this species, *Falco cayennensis* Gmelin (Syst. Nat. 1, i. 1788, p. 269) being preoccupied by *Falco cayennensis* of the same author (l. c. p. 263).

† *Columba crissalis* Salvadori, Cat. B. Brit. Mus. xxi. p. 294 (1893.—Costa Rica, etc.).

‡ Erroneously spelt "Japayo."

§ Ann. Carnegie Mus. vi. Nos. 2-4, p. 395 (1910.—Guápiles, Costa Rica).

the throat light pearl-grey instead of vinous, the foreneck and breast much paler, plumbeous washed with lilac, and the abdomen dull vinous-brown. The bright cinnamon-rufous colour of the under wing-coverts and inner webs of the remiges serves to distinguish it at a glance from *C. plumbea bogotensis* Berl. & Lev. and *C. subvinacea berlepschi* Hart. *, found in the same districts.

C. goodsoni is peculiar to the forest-covered lowlands (from sea-level to about 500 feet) of N.W. Ecuador (province Esmeraldas) and Western Colombia.

191. *GEOTRYGON VERAGUENSIS CACHABIENSIS* Hart.

[*Geotrygon veraguensis* Lawrence, Ann. Lyc. N. H. N. Y. viii. p. 349 (1866.—Veragua).]

G. veraguensis cachabiensis Hartert, Nov. Zool. v. p. 504 (1898.—Cachabi, N.W. Ecuador).

G. v. cachabiensis Hartert, l. c. ix. 1902, p. 603 (S. Javier, Rio Sapayo, N.W. Ecuador; crit.).

No. 2444. ♂ ad. Noanama (100 ft.), 5.i.08.—Wing 134; tail 76; bill $18\frac{1}{2}$ mm.

“Iris yellow, feet crimson, bill black.”

This specimen is decidedly darker sepia-brown on the back and wings, and has a stronger violet-purple gloss on the upper mantle than a single Costa Rican skin of true *G. v. veraguensis*. The same differences were noticed by Hartert in a series from N.W. Ecuador.

G. v. cachabiensis replaces the typical race in the Pacific lowlands of W. Colombia and the adjoining parts of Ecuador (province Esmeraldas).

192. *GEOTRYGON BOURCIERI* Bonap.

Geotrygon bourcierii Bonaparte, Consp. Av. ii. p. 71 (Nov. 1854.—Lloa, Ecuador).

No. 2816. ♀ ad. Pueblo Rico (5200 ft.), 27.x.09.—Wing 155; tail 98; bill 17 mm.

“Iris yellow, feet light red; bill black.”

Compared with two fine adults from Ecuador (Aguapum) this bird has the flanks slightly deeper rufous, and the forehead less rosy, but these variations are very trifling.

This rare Pigeon was hitherto known only from Western Ecuador (? and N. Peru) and the present record extends its range considerably to the north.

193. *RHYNCHORTYX CINCTUS* Salv.

Odontophorus cinctus Salvin, Ibis, (3) vi. p. 379 (1876.—Veragua; = ♀).

O. spodiostethus Salvin, Ibis, (4) ii. p. 447 (1878.—Veragua; = ♂).

* Nov. Zool. v. p. 504 (1908.—Paramba, N.W. Ecuador).

Rhynchortyx cinctus Hartert, Nov. Zool. ix. 1902, p. 600 (Bulón, Rio Bogotá, Pambilár, N.W. Ecuador; crit.).

Nos. 2119, 2125. ♂ ♂ ad. Sipi (150 ft.): 25, 28.ix.08.—Wing 116, 120; tail 45; bill 17 mm.

No. 2126. ♀ ad. Sipi: 28.ix.08.—Wing 116; tail 44; bill 17 mm.

"Iris brown, feet blue, maxilla black, mandible grey."

These specimens fully bear out the conclusions arrived at by Hartert from the study of a series from N.W. Ecuador, viz., that *O. cinctus* and *O. spodiostethus* have been established upon phases of one and the same species. The two skins, marked as "♂" by the collector, agree substantially with the description of *O. spodiostethus*, having the sides of the head and throat bright ferruginous, the chest dark cinereous, and the rest of the belly deep ochraceous buff, the flanks finely vermiculated with dusky, and the under tail-coverts only distinctly barred with black, etc.

The third specimen, sexed as "female," tallies well with the description of *O. cinctus*. It has the head above, nape, and chest deep rufous-brown, while the remaining under parts are white, broadly banded with black, except down the middle of the abdomen; chin and upper throat are white; there is but an indistinct, buffy whitish superciliary stripe, etc.

While there cannot be any further question as to *O. cinctus* being the female, and *O. spodiostethus* the male of the same species, yet the comparison of a good series from Veragua might show the birds from the Pacific coast district of Colombia and N.W. Ecuador to be slightly different. In fact, the Sipi female differs from Salvin's and Grant's descriptions in having the lower back and rump bright rufescent brown, finely vermiculated with dusky and spotted with black, especially down the centre, instead of "dark grey or vinaceous, mottled with whitish."

R. cinctus, wherever it occurs, appears to be a rare bird. It has been recorded from the Escondido River (Nicaragua), Panama, Veragua, the Chocó district (W. Colombia), and from the province of Esmeraldas (N.W. Ecuador).

194. CHAMÆPETES GOUDOTII GOUDOTII LESS.

Ortalia Goudotii Lesson, Man. d'Ornith. ii. p. 217 (1828—"les montagnes du Quindí," Colombia).

Chamæpetes goudoti Sclater & Salvin, P. Z. S. 1879, p. 544 (Retiro).

No. 2795. ♂ ad. Tatamá Mountain, 4600 ft., 14.x.09.—Wing 255; tail 245; bill 33 mm.

"Iris crimson, feet vermilion, bill black, bare space round the eye dark blue."

Identical with a specimen from Bogotá. Birds from Ambato, E. Ecuador, are much brighter rufous underneath. They are certainly subspecifically distinct and may belong to *C. g. rufiventris* Tsch., from Perú, which I have not yet met with.

195. *NOTHOCERCUS INTERCEDENS* Salvad..

Nothocercus intercedens Salvadori, Cat. B. Brit. Mus. xxvii. p. 513 (1895.—Frontino, W. Colombia).

N. bonapartii (nec Gray) Sclater & Salvin, P. Z. S. 1879, p. 548 (Frontino, Concordia).

No. 2728. ♀ ad. Pueblo Rico (5200 ft.), 16.viii.09.—Wing 203; tail 70; bill 32 mm.

“Iris dark brown, feet grey, maxilla black, mandible grey.”

The specimen agrees with Salvadori's description. The throat is white, washed with pale rufescent buff on its lower portion. The rump, upper tail-coverts, wings, as well as the abdomen, are marked with numerous white or buffish dots.

N. intercedens is peculiar to the Western Cordillera of Colombia (Frontino, Concordia, Pueblo Rico). In southern Central America it is represented by *N. frantzii* Lawr.*, in the Eastern Cordillera and in the mountains of Western Venezuela by *N. bonapartei* Gray †.

196. *CRECISCUS ALBIGULARIS* Lawr.

Corethrura albigularis Lawrence, Ann. Lyc. N. H. N. Y. vii. p. 302 (Jan. 1861.—Panama Railroad).

Porzana albigularis Sclater & Salvin, P. Z. S. 1879, p. 546 (Remedios).

Creciscus albigularis Hartert, Nov. Zool. ix. 1902, p. 604 (S. Javier, N.W. Ecuador).

No. 2144. ♂ vix ad. Sipi, Rio Sipi, 1.x.08.—Wing 75; tail 30; bill 18 mm.

“Iris orange-yellow, feet dark greenish brown, bill black.”

This bird agrees with typical Panama specimens, the head above being russet-brown, the chin and upper throat conspicuously white, etc. There are a few cinnamon-rufous spots, but no white bars, on the upper wing-coverts.

C. albigularis ranges from Panama south to N.W. Ecuador (San Javier, province Esmeraldas).

197. *JONORNIS MARTINICA* Linn.

Fulica martinica Linnæus, Syst. Nat. 12, i. p. 259 (1766—“in Martinicæ inundatis”).

Porphyrio martinicus Sclater & Salvin, l. c. p. 546 (Medellin).

No. 2713. ♀ ad. Tadó (230 ft.), 18.vi.09.

“Iris light brown, feet yellowish brown, bill red, tip yellow.”

198. *ARAMIDES WOLFEI* Berl. & Tacz.

Aramides wolfei Berlepsch & Taczanowski, P. Z. S. 1883, p. 576

* *Tinamus frantzii* Lawrence, Ann. Lyc. N. H. N. Y. ix. p. 140 (1868.—Cervantes, Costa Rica).

† *Tinamus bonapartei* G. R. Gray, List Spec. B. Brit. Mus., v. Gallinæ, p. 97 (1867.—Valley of Aragua, W. Venezuela).

(1884.—Chimbo, S.W. Ecuador); Salvadori & Festa, Boll. Mus. Torino, xv. no. 368, p. 40 (Rio Peripa, W. Ecuador): Hartert, Nov. Zool. ix. 1902, p. 604 (Pambilár, Carondelet, N.W. Ecuador).

No. 2264. ♀ ad. Nóvita: 11.xi.08.—Wing 160; tail 70; bill 55 mm.

"Iris scarlet, feet crimson, bill green, tip paler."

This skin agrees perfectly with others from N.W. Ecuador, notably with an adult female from Carondelet. Salvadori and Festa (*l. c.*) have already pointed out that the description in the Cat. B. Brit. Mus. xxiii. p. 55, is not quite exact.

A. wolfti is nearest to *A. mangle* Spix* and agrees with it in the clear cinereous colour of the head and neck above, and in the whitish throat, but may at once be distinguished by its much larger bill, deep olivaceous-brown back, this colour passing into rufous-brown on the mantle, black (instead of greyish) lower abdomen and thighs, much darker, ruddy brown breast and upper belly, etc.

A. wolfti is new to the fauna of Colombia. It was only reported as an inhabitant of Western Ecuador.

199. DENDROCYGNA DISCOLOR Sel. & Salv.

Dendrocygna discolor Selater & Salvin, Nomencl. Av. Neotrop. p. 161 (1873.—"Venezuela, Guiana, et Brasilia," type from Surinam, *cfr.* Cat. B. Brit. Mus. xxvii. p. 162).

D. autumnalis (nec Linnæus) Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 197 (R. Truando).

No. 2193. ♀ ad. Mouth of Rio Sipi, near Noanama, 15.x. 08.—Wing 225; tail 62; bill 50 mm.—"Iris black, feet and bill blood-red."

Typical of *D. discolor*, the lower hind neck being buffy grey, abruptly contrasted with the chestnut-brown back.

D. discolor is widely distributed in South America south of the Panama Isthmus.

200. QUERQUEDULA CYANOPTERA Vieill.

Anas cyanoptera Vieillot, Nouv. Dict. v. p. 104 (1816—"rivière de La Plata et à Buenos Aires").

No. 2150. ♀ ad. Sipi: 3.x.08.—Wing 175; tail 70; bill 40 mm.

"Iris black, feet putty brown, maxilla blue-grey, mandible flesh-coloured."

201. CARBO VIGUA Vieill.

Hydrocorax vigua Vieillot, Nouv. Dict. viii. p. 90 (1817—*ex* Azara: Paraguay).

* *Gallinula mangle* Spix, Av. Bras. ii. p. 74, pl. 97 (1825.—Brazil).

Carbo brasiliensis? Cassin, Proc. Acad. N. Sci. Philad. 1860, p. 197 (R. Truando).

No. 2045. ♀ imm. Noanama: l.ix.08.—“Iris emerald-green, feet black, maxilla grey, mandible yellow.”

IV. Conclusions.

Although our knowledge of Western Colombia is still very far from complete, yet the researches of the naturalists mentioned in the first part furnish sufficient evidence on which to base some conclusions as to the general character and affinities of the avifauna of this remote district. As might be expected from its geographical situation, the fauna of Western Colombia shows a mixed character, being composed partly of Ecuadorian and partly of Central American species, the former, however, by far preponderating. The most interesting result derived from Mr. Palmer's collection is evidence of close similarity of the avifauna of the San Juan Valley to that of the province of Esmeraldas, N.W. Ecuador. In fact quite a number of remarkable species are apparently peculiar to S.W. Colombia and the adjoining parts of N. Ecuador, while in the more southern districts of Western Ecuador other more or less allied forms take their place. In several instances, however, the Chocó region has a species or subspecies of its own, while the province of Esmeraldas is inhabited by a representative form generally distributed over Western Ecuador.

A few species range from Panama to N.W. Ecuador, but do not go further south. Several others extend from Panama to the Dagua district, whereas in N.W. Ecuador another species or race is found.

The subjoined tabular lists † may serve to illustrate these facts, which are of some importance to the student of zoogeographical problems.

(A) Species peculiar to Western Colombia (Chocó district) and N.W. Ecuador (province Esmeraldas).

<i>Turdus tristis daguæ.</i>	<i>Dendroornis lachrymosa rostrata.</i>
<i>Henicorhina inornata.</i>	<i>Cercomacra berlepschi.</i>
<i>Calospiza johannæ.</i>	* <i>Caprimulgus rosenbergi.</i>
<i>Elania cinerea parambæ.</i>	<i>Polyerata rosenbergi.</i>
<i>Rhynchocyclus cinereiceps flavotectus.</i>	* <i>Eucephala humboldti.</i>
<i>Mionectes olivaceus hederaceus.</i>	<i>Pionopsitta pulchra.</i>
<i>Chloropipo holochlora litæ.</i>	<i>Columba goodsoni.</i>
<i>Sapayoa ænigma.</i>	<i>Geotrygon veraguensis cachabiensis.</i>
<i>Carpodectes hopkei.</i>	<i>Leucopternis plumbea.</i>
<i>Automolus nigricauda.</i>	etc., etc.

† The species not represented in Mr. Palmer's collection, but procured by previous travellers, are marked with an asterisk (*).

(B) Species peculiar to Western Colombia.

Represented in W. Ecuador by

<i>Heleodytes albobrunneus.</i>	
<i>Thryophilus nigricapillus schottii.</i>	<i>T. n. nigricapillus.</i>
<i>Euphonia xanthogaster chocoensis.</i>	<i>E. x. xanthogaster</i> (?)
<i>E. f. fulvicrissa.</i>	<i>E. fulvicrissa purpurascens</i> (N.W.).
<i>Chlorochrysa nitidissima.</i>	<i>C. phoenicotis.</i>
<i>Calospiza palmeri.</i>	
<i>Euthraupis melanocephala.</i>	<i>B. rothschildi</i> (N.W.).
<i>B. aureocincta.</i>	<i>B. edwardsi</i> (also in S. Colombia: Pasto).
* <i>Ostinops salmoni.</i>	<i>O. atrocaeruleus.</i>
<i>Masiis chrysopterus bellus.</i>	<i>M. c. coronulatus.</i>
<i>Siptornis erythrops griseigularis.</i>	<i>S. e. erythrops.</i>
<i>Thripadectes sclateri.</i>	
<i>Anoplops bicolor daguæ.</i>	<i>A. b. æquatorialis.</i>
<i>Pittasoma rosenbergi.</i>	<i>P. rufopileatum</i> (N.W.).
<i>Phæthornis yaruqui sancti-johannis.</i>	<i>P. y. yaruqui.</i>
<i>Thalurania fannyi.</i>	<i>T. verticeps.</i>
* <i>Adelomyia cervina.</i>	<i>A. melanogenys maculata.</i>
<i>Cyanolestia kingii</i> subsp.	<i>C. k. cælestis.</i>
<i>Bucco noanæ.</i>	
<i>Capito quinticolor.</i>	
<i>C. maculicoronatus</i> (north to Panama).	<i>C. squamatus.</i>
<i>Monasa pallescens.</i>	
<i>Chloronotus rubiginosus gularis.</i>	
* <i>Picumnus olivaceus granadensis.</i>	<i>P. o. harterti.</i>
<i>Pteroglossus e. sanguineus</i> (north to the Truando, south to N.W. Ecuador).	<i>P. erythropygus erythropygus</i> (C. & S.W. Ecuador).
<i>Odontophorus parambae baliolus.</i>	<i>O. parambae parambae.</i>
<i>Nothocercus intercedens.</i>	

(C) Species ranging from Panama to N.W. Ecuador, but not known to occur elsewhere.

<i>Chlorochrysa vitellina.</i>	<i>Bucco pectoralis.</i>
<i>Pachyrhampus dorsalis.</i>	<i>B. tectus subtectus.</i>

(D) Species ranging from Panama to the Chocó district, W. Colombia.

<i>Cotinga nattererii.</i>	<i>Capito maculicoronatus.</i>
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(E) Species of Western Colombia† represented in southern Central America (Panama, Costa Rica) by nearly allied forms.

Western Colombia.

- **Turdus tristis daguae*.
Heleodytes albobrunneus harterti.
†*Leucolepis p. phaeocephalus*.
Thryophilus nigricapillus schottii.
†*T. leucopogon*.
**Henicorhina inornata*.
†*Basileuterus t. tristriatus*.
**Dacnis venusta fuliginata*.
D. cayana caerebicolor.
†*Sporophila ophthalmica*.
**Calospiza lavinia lavinia*.
C. gyroloides gyroloides.
**C. johannae*.
**C. larvata fanny*.
Buthraupis melanocephala.
**Heterospingus xanthopygius*.
**Hemithraupis salmomi*.
†*Cacicus uropygialis*.
Cyanocorax affinis affinis.
**Rhynchocyclus cinereiceps flavotectus*.
†*Mionectes olivaceus hederaceus*.
Myiobius sulphureipygus villosus.
†*Pipra mentalis minor*.
Chironomachæris vitellina.
†*Tityra semifasciata columbiana*.
**Lathria unirufa castaneotincta*.
**Lipaugus holerythrus rosenbergi*.
**Carpodectes hopkei*.
Siptornis erythrops griseigularis.
†*Hylocistes subulatus assimilis*.
†*Xenops genibarbis littoralis*.
**Dendromis lachrymosa rostrata*.
†*D. triangularis equatorialis*.
†*Myrmotherula fulviventris vidua*.
†*Formicivora quixensis consobrina*.
†*Ramphocæmus c. cinereiventris*.
†*Myrmelastes exsul maculifer*.
Anoplops bicolor daguae.
†*Formicarius analis destructus*.

Pittasoma rosenbergi.
†*Threnetes ruckeri fraseri*.
**Chalybura urochrysa*.
Chloroncrpes rubiginosus gularis.
Picumnus olivaceus granadensis.
†*Malacoptila panamensis polioptis*.

Central America.

- T. tristis cnephosa*.
H. a. albobrunneus.
L. p. lawrencii.
T. semibadius.
T. thoracicus.
H. leucosticta prosthaleuca.
B. tristriatus melanotis.
D. v. venusta.
D. c. ultramarina.
S. aurita.
C. lavinia dalmasi.
†*C. gyroloides bangsi*.
C. florida florida and *C. florida arcæi*.
C. larvata subsp.
B. arcæi.
H. rubrifrons.
H. chrysometas.
C. microrhynchus.
C. a. zeledoni.
R. c. cinereiceps.
M. o. olivaceus.
M. s. aureatus.
P. mentalis iugifera.
C. aurantiaca.
T. s. costaricensis.
L. u. clara.
L. h. holerythrus.
C. nitidus.
S. e. rufigenis.
H. s. virgatus.
X. g. mexicanus.
D. l. lachrymosa.
D. t. punctigula.
M. f. fulviventris.
F. g. boucardi.
R. c. semitorquatus.
M. e. exsul.
A. b. bicolor.
F. a. nigricapillus (Eastern Costa Rica).
P. michleri (Panama).
T. r. ruckeri.
C. isauræ (Veragua).
C. r. uropygialis.
P. o. panamensis (Panama).
M. p. panamensis.

† When also occurring in the province of Esmeraldas (N.W. Ecuador), they are marked with an asterisk (*); when more generally distributed in Western Ecuador, with a dagger (†).

Western Colombia (*cont.*).*Aulacorhamphus albivitta phaeolæmus* §.**Pionopsitta pulchra*.**Columba goodsoni*.**Geotrygon veraguensis cachabensis*.*Nothocercus intercedens*.Central America (*cont.*).*A. ceruleigularis*.*P. hæmatotis*.*C. nigrirostris brunneicauda*.*G. v. veraguensis*.*N. frantzii*.

The evidence at hand is hardly sufficient to allow an exact comparison of the fauna of Western Colombia with that of the Central Cordillera, yet from what we know it appears that the Pacific lowlands and foot-hills possess a considerable number of peculiar elements, e. g. *Supaya ænigma*, *Onipodectes subbrunneus*, *Carpodectes hopkei*, etc. Some of the species recorded only from the Western Cordillera may turn up in the Central Cordillera; but, on the other hand, it is quite certain that a good many forms that inhabit the central mountain-chain are altogether absent from the Pacific slopes.

A thorough exploration of Southern and Central Colombia cannot be too warmly recommended to the attention of ornithologists, as offering a wide field for the solution of various zoogeographical problems.

§ *Aulacorhamphus phaeolæmus* Gould, Ann. Mag. N. H. (4) xiv. p. 184 (1874.—Concordia, Western Cordillera of Colombia (and Merida, in Venezuela—errore!)).

A. petax Bangs, Proc. Biol. Soc. Wash. xxi. p. 158 (1908.—San Antonio, R. Cali, Western Cordillera of Colombia).

There can be no doubt that the blue-throated *Aulacorhamphus*, of the Western Cordillera, has to bear the name *A. a. phaeolæmus*, which Mr. Bangs appears to have overlooked. Although in the Cat. B. Brit. Mus. xix. p. 158, a specimen from Merida, Venezuela, is given as type, this cannot be correct, for Gould (*l. c.*) clearly described the Concordia bird (*cf.* "throat deep greyish blue"). It may be mentioned that the Merida form was erroneously referred to *phaeolæmus* by Gould, since a series in the Munich Museum undoubtedly belongs to *A. a. albivitta*, all the examples having the throat white.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

October 24th, 1911.

Sir JOHN ROSE BRADFORD, K.C.M.G., M.D., F.R.S.,
Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions that had been made to the Society's Menagerie during the months of June, July, August, and September 1911.

Mr. JAMES DUNBAR-BRUNTON sent for exhibition two skins and a mounted skull, with horns, of Bushbuck shot by him in North-East Rhodesia.

Mr. W. B. COTTON, of the Indian Civil Service, exhibited a number of heads and horns of various species of Gazelles which he had obtained in the Eastern Sudan, and gave a brief account of their habits and distribution.

Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens, exhibited two photographs of a living male specimen of Red-fronted Gazelle (*Gazella rufifrons*) which was presented to the Society by Col. Julian Hasler in May 1908, and came from Kano in Northern Nigeria. This specimen he proposed to make the type of a new subspecies to be named *G. rufifrons hasleri*, since it differed apparently from all previously recorded races of that species in having the upper side of the nose pure white from the nostrils back to the preorbital glands.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. J. LEWIS BONHOTE, M.A., F.Z.S., exhibited two "waltzing" Rats (*Mus rattus*) which he had bred in the course of his experiments. They appeared in the F_2 generation, and it was noted that the strain had become weak and degenerate, other individuals of that generation being born blind or otherwise defective. As the "waltzing" character had been proved to have a Mendelian inheritance in Mice, it would be an interesting fact that, should this character prove to have a Mendelian inheritance in Rats, it would be a case of the genesis of a Mendelian character brought about by artificial conditions, *e. g.* environment. The original stock were normal wild individuals. Mr. Bonhote also pointed out that the two varieties of *M. rattus* found in Egypt, viz. *M. r. tectorum* with white underparts and *M. r. alexandrinus* with dark underparts, had a Mendelian inheritance, the former white-bellied form being dominant to the dark-bellied form. These experiments also included the study of the inheritance of a fawn-coloured variety, hitherto unknown, which appeared as a "sport" from wild-caught parents. This variety had also a Mendelian inheritance, the fawn-coloured ones being recessive to both the normal wild forms.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a spirit-specimen of a nestling Australian Regent-Bird (*Sericulus melinus*) which had been hatched in the aviary of Mr. Reginald Philipps, of 26 Cromwell Grove, West Kensington, during the past summer.

Mr. E. G. BOULENGER, Curator of Reptiles, gave the description of a new Tree-Frog from Trinidad, living in the Society's Gardens. The Frog, which was brought back by Dr. Lewis H. Gough in July last, was one of the smallest of the genus *Hyla*, and was remarkable for the rapid changes in colour and markings which it displayed.

Mr. BRUCE F. CUMMINGS read a paper, communicated by Mr. T. A. COWARD, F.Z.S., on "Distant Orientation in Batrachia," based on observations and experiments made by the author in North Devon. Two species of Newts had been used for the experiments, and the results obtained lent support to the hypothesis that these batrachians possessed a homing faculty, but no very definite instinct for detecting water, even from a short distance. Of the factors discussed in connection with amphibian migration, it was suggested that in regard to Newts, a combination of their homing faculty and their marked tendency to walk downhill was chiefly of assistance to them in finding water in which to breed.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., read a paper on Mammals collected in the Provinces of Sze-chwan and Yunnan, W. China, by Mr. Malcolm Anderson, for the Duke of Bedford's Exploration

of Eastern Asia. The paper formed No. XV. of the series, and would be the last on Mr. Anderson's specimens, as he was now returning finally to America. During his work on the exploration he had obtained 2700 specimens, besides many birds, and had quite revolutionized our knowledge of the area explored.

The present collection, given, as before, to the National Museum by the Society's President, consisted of 160 specimens, belonging to 33 species. The following were described as new:—

RHYNCHONAX ANDERSONI, gen. et sp. nn.

Allied to *Uropsilus soricipes*, but with p^3 and i_3 present; no p_3 .

Head and body 70 mm.; tail 67; hind foot 15·5; skull 21·7.

Hab. Omi-san. *Type.* Male. No. 11.2.1.25. M.P.A. 2504.

NASILUS GRACILIS, gen. et sp. nn.

Allied to the above, but with p^3 and p_3 present; no i_3 .

Head and body 66 mm.; tail 55; hind foot 13·5; skull 20·5.

Hab. Chin-fu-san. *Type.* Female. No. 2566.

SOREX WARDI FUMEOLUS, subsp. n.

Larger and darker-coloured than true *wardi*; the brain-case broader.

Head and body 60 mm.; tail 60; hind foot 13; skull 18·1.

Hab. Wei-choe, Si-ho R. *Type.* Male. No. 2627.

SORICULUS IRENE, sp. n.

Allied to *macrurus*, but brain-case lower.

Head and body 60 mm.; tail 90; hind foot 16; skull 17·2.

Hab. Yuen-ching, Sze-chwan. *Type.* Female. No. 2673.

CHODSIGOA LARVARUM, sp. n.

Near *Ch. hypsibia*, but brain-case narrower and higher.

Head and body 68 mm.; tail 50; hind foot 14; skull 18·8.

Hab. Imperial tombs E. of Peking. *Type.* Female. B.M. No. 8.8.7.21.

APODEMUS SPECIOSUS ORESTES, subsp. n.

Size medium. Tail long; ears medium. Colour near sepia.

Head and body 93 mm.; tail 125; hind foot 24; ear 16.

Hab. Omi-san. *Type.* Male. B.M. No. 11.2.1.170.

APODEMUS SPECIOSUS LATRONUM, subsp. n.

Size large. Tail short; ears long. Colour brown.

Head and body 107 mm.; tail 101; hind foot 25; ear 20.

Hab. Ta-tsien-lu. *Type.* Male. B.M. No. 11.2.1.156.

MICROTUS MILLICENS, sp. n.

Skull flattened; an extra angle on m^2 ; tail long.

Head and body 90 mm.; tail 53; hind foot 18·5; skull 24·3.

Hab. Wei-choe, Si-ho R. *Type.* Male. No. 2615.

MICROTUS (EOTHENOMYS) MELANOGASTER ELEUSIS, subsp. n.

Tail comparatively long; m^3 with four inner angles.

Head and body 98 mm.; tail 55; hind foot 17; skull 24.7.

Hab. E. of Chao-tung-fu, N. Yunnan. *Type.* Male. No. 2696.

MICROTUS (EOTHENOMYS) OLITOR, sp. n.

Near *M. melanogaster*, but no extra internal angle on m^1 .

Head and body 82 mm.; tail 34; hind foot 16; skull 24.

Hab. Chao-tung-fu. *Type.* Female. No. 2714.

MICROTUS (CARYOMYS) ALCINOUS, sp. n.

Like *M. (C.) eva*, but colour very much darker.

Head and body 90 mm.; tail 56; hind foot 17; skull 24.

Hab. Wei-choe, Si-ho R. *Type.* Male. No. 2631.

The SECRETARY presented a paper by Mr. E. P. STEBBING, F.L.S., F.Z.S., entitled "Game Sanctuaries and Game Protection in India," in which the author discussed the question of the formation of Game Sanctuaries and what had been already done in this direction in various parts of the country. Suggested additions to the proposed New Indian Game Act were given, and "close seasons" for certain species recommended as being necessary for the preservation of the game of the country.

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 7th, 1911, at half-past Eight o'clock P.M., when the following communications will be made:—

1. R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

Lantern exhibition on the Moulting of the Arctic Fox.

2. D. SETH-SMITH, F.Z.S., M.B.O.U.

On the Moulting of the King Penguin (*Aptenodytes pennanti*) in the Society's Gardens. (With lantern illustrations.)

3. T. E. GUNN, F.L.S.

On the Presence of Two Ovaries in certain British Birds, more especially the Falconidæ. (With lantern illustrations.)

4. Prof. P. P. SUSHKIN, C.M.Z.S.

Ontogenetical Transformations of the Bill in *Ardea cinerea*.

5. A. D. IMMS, D.Sc., B.A.

On some Collembola from India, Burma, and Ceylon, with a Catalogue of the Oriental Species of the Order.

The following papers have been received:—

1. H. B. PRESTON, F.Z.S.

Diagnoses of New Species of Terrestrial and Fluvatile Shells from British and German East Africa.

2. R. LYDEKKER.

On the Milk-Dentition of the Ratel.

3. ALFRED E. CAMERON, M.A., B.Sc.

Structure of the Alimentary Canal of the Stick Insect (*Bacillus rossii* Fabr.), with a Note on the Parthenogenesis of this Species.

4. ROBERT SHELFORD, M.A., F.Z.S.

Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta* Sauss.

5. The Rev. O. PICKARD-CAMBRIDGE, F.R.S., C.M.Z.S.

Contributions to the Knowledge of the Spiders and other Arachnids of Switzerland.

6. J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.

A further Collection of Mammals from Egypt and Sinai.

7. J. T. CUNNINGHAM, M.A., F.Z.S.

Mendelian Experiments on Fowls.

8. Prof. GEOFFREY SMITH, M.A.

The Freshwater Crayfishes of Australia.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
October 31st, 1911.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 7th, 1911.

FREDERICK GILLET, Esq., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. F. MENTEITH OGILVIE, F.Z.S., communicated a paper by Mr. T. E. GUNN, F.L.S., "On the Presence of Two Ovaries in certain British Birds, more especially the Falconidæ." The author outlined the views held by the majority of English morphologists on the reproductive organs of adult female birds, and enumerated examples which he had collected during a number of years where the right as well as the left ovary was present, and, so far as could be ascertained, in the two cases of which sections had been made, where the right ovary was functional. He pointed out the extraordinary preponderance in his examples of paired ovaries occurring in the Falconidæ, as compared with those derived from any other source, and remarked that in that family the ovaries were usually placed symmetrically one on either side of the vertebral column and at about the same level. In examples other than the Falconidæ this symmetrical arrangement was the exception rather than the rule, the right ovary generally occupying a position almost directly below the left, in the left half of the body-cavity, which, in the author's opinion, suggested a half-way home on the road leading to the final disappearance of the right ovary.

Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens, exhibited a series of lantern-slides prepared from

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photographs taken by Mr. P. W. Farmborough, F.Z.S., illustrating the colour-change and phases in the moult of an Arctic Fox now living in the Society's Gardens.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, read a paper, illustrated by lantern-slides, on the Moulting of the King Penguin (*Aptenodytes pennanti*) in the Society's Gardens. He referred to Mr. de Winton's paper on the same subject which appeared in the 'Proceedings' in 1898. The specimen observed by Mr. de Winton did not moult until it had lived sixteen months in the Gardens, whereas the specimen now in the menagerie had moulted twice in six months.

The author stated that the new feathers were almost fully grown before the old ones were shed, and that the latter had to be rubbed off by the bird's beak or feet, as they were firmly attached to the sheaths of the new feathers. The paper was illustrated by photographs, which showed the bird in various stages of the moult, as well as by specimens of the shed feathers.

Dr. S. F. HARMER, M.A., F.R.S., V.P.Z.S., read a paper by Prof. A. D. IMMS, D.Sc., B.A., entitled, "Some Collembola from India, Burma, and Ceylon, with a Catalogue of the Oriental Species of the Order." Four genera and twenty-eight species were described as new, amongst the latter the most remarkable being a form unique among Collembola in possessing a median cercus to the fifth abdominal segment, and for the reception of which a new subfamily was formed. The total number of Collembola known from the Oriental region was stated to amount to 53 species comprised within 27 genera.

A paper on the "Ontogenetical Transformations of the Bill in *Ardea cinerea*," by Prof. P. P. SUSHKIN, C.M.Z.S., was read by Mr. D. SETH-SMITH, F.Z.S. The author gave a description of the gradual development of the bill in a series of embryos and young specimens of the Heron upon which he had made observations. The simple rhamphotheca proved to be only a late stage of the compound one, and the form of the Ardeine bill he regarded as a derivative one, and discussed its resemblance to those of allied forms.

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 21st, 1911, at half-past Eight o'clock P.M., when the following communications will be made :—

1. DR. GEOFFREY SMITH, M.A.

The Freshwater Crayfishes of Australia.

2. FRANK E. BEDDARD, M.A., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—III. On a New Genus of Tapeworms from the Bustard (*Eupodotis kori*).

3. ALFRED E. CAMERON, M.A., B.Sc.

Structure of the Alimentary Canal of the Stick Insect (*Bacillus rossii* Fabr.), with a Note on the Parthenogenesis of this Species.

4. G. A. BOULENGER, F.R.S., F.Z.S.

Some remarks on the Habits of British Frogs and Toads, with reference to Mr. Cummings's recent communication on "Distant Orientation in Amphibia."

5. H. B. PRESTON, F.Z.S.

Diagnoses of New Species of Terrestrial and Fluvial Shells from British and German East Africa.

6. R. LYDEKKER.

On the Milk-Dentition of the Ratel.

The following papers have been received :—

1. ROBERT SHELFORD, M.A., F.Z.S.

Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta* Sauss.

2. The Rev. O. PICKARD-CAMBRIDGE, F.R.S., C.M.Z.S.

Contributions to the Knowledge of the Spiders and other Arachnids of Switzerland.

3. J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.

A further Collection of Mammals from Egypt and Sinai.

4. J. T. CUNNINGHAM, M.A., F.Z.S.

Mendelian Experiments on Fowls.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

November 14th, 1911.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 21st, 1911.

S. F. HARMER, Esq., M.A., Sc.D., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions that had been made to the Society's Menagerie during the month of October 1911.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited two living examples of an Elephant-Shrew (*Macroscelides* sp.) from Bechuanaland, which had been presented to the Society by Capt. H. O. F. Littledale and forwarded by Dr. L. Péringuey, C.M.Z.S., and remarked that these specimens, together with another in the same consignment, but belonging to a different species, were apparently the first representatives of the genus *Macroscelides* the Society had ever possessed. After drawing attention to some interesting structural features shown by the animals, Mr. Pocock said that the Society was to be congratulated upon the safe arrival of these Elephant-Shrews, because, apart from members of the Hedgehog-family, which from being omnivorous are more easy to preserve in captivity, exotic species of Insectivora are proverbially difficult to keep alive for any length of time and are therefore seldom exhibited in the Gardens.

Dr. GEOFFREY SMITH, M.A., read a paper, communicated by the SECRETARY, entitled "The Freshwater Crayfishes of Australia."

The object of this paper was to revise the classification and

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nomenclature of the Australian and Tasmanian Crayfishes, and to give diagnoses of the genera and species with their limits of distribution. The work was based on a large material obtained from all parts of the continent and from Tasmania. Many of the specimens had been collected by the author, but the majority formed a very large collection brought together during the past twenty years by Prof. Baldwin Spencer.

Four genera were recognised, *Astacopsis*, *Chærops*, *Parachærops*, and *Engæus*: the first three genera included the Freshwater Crayfishes proper, and the last-named genus contained the Land-Crayfishes, which were not dealt with in this paper.

The geographical distribution of these genera and its bearing upon the geographical problems of Australia was discussed, and the view was supported that the Bassian Subregion represented the home of the Australian Crayfish, and that *Astacopsis* was nearest the ancestral form.

MR. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, presented a paper on "A new Genus of Tapeworms from the Bustard (*Eupodotis kori*)."

Four complete specimens and some fragments of this Cestode had been obtained from a S. African Bustard in the Society's Gardens, and the author regarded it as a member of the group Tetracotylea, but could not reconcile its characters with those of any other genus of that group at present known. He briefly described its anatomical characters and discussed its systematic position, and proposed a new genus and species for its reception.

THE SECRETARY presented a memoir by Mr. A. E. CAMERON, M.A., B.Sc., entitled "The Structure of the Alimentary Canal of the Stick-Insect, *Bacillus rossii*, Fabr., with a Note on the Parthenogenesis of this Species."

The author stated that this insect had a rather limited distribution, occurring in the south of Europe and in the north of Africa, and that in the wild state it was not found north of Orleans. Certain peculiarities of the alimentary canal were dealt with which were regarded as adaptations to the mode of life of the species. Attention was drawn to the fact that the male was only rarely found in the wild state, and that parthenogenetic reproduction of *B. rossii* had been verified, for during four generations the specimens kept by the author had showed no males. The fact that the males were disappearing suggested that parthenogenesis was not the primitive method of reproduction, but that the species had become adapted to it through the failure of sexual reproduction.

MR. H. B. PRESTON, F.Z.S., communicated a paper based on a collection of Terrestrial and Fluvial Shells made by Mr. Robin Kemp in British and German East Africa. One new genus and thirty-four new species were described, which represented only a very small portion of the large number of species collected

Mr. E. G. BOULENGER, F.Z.S., presented a short paper by Mr. G. A. BOULENGER, F.R.S., F.Z.S., containing some remarks on the habits of British Frogs and Toads, for the information of those who might feel inclined to carry out further observations on the subject of the migrations of Amphibia as dealt with in a paper recently read before the Society. The Common Toad was strongly recommended as the most suitable Batrachian on which to institute series of experiments on Distant Orientation.

A paper on the "Milk-Dentition of the Ratel" was received from Mr. R. LYDEKKER, in which he described an instance of primitive features present in the milk-dentition being entirely lost in the teeth of the permanent series. So far as he was aware, no such atavistic feature had been hitherto recorded in the case of any existing mammals.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 6th, 1912, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Mrs. R. HAIG THOMAS, F.Z.S.

On Experimental Pheasant Breeding.

2. J. T. CUNNINGHAM, M.A., F.Z.S.

Mendelian Experiments on Fowls.

3. H. G. PLIMMER, F.R.S., F.L.S., F.Z.S.

Report on the Deaths which occurred in the Zoological Gardens during 1911,

4. J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.

A further Collection of Mammals from Egypt and Sinai.

The following papers have been received:—

1. ROBERT SHELFORD, M.A., F.Z.S.

Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta* Sauss.

2. THE REV. O. PICKARD-CAMBRIDGE, F.R.S., C.M.Z.S.

Contributions to the Knowledge of the Spiders and other Arachnids of Switzerland.

3. HERBERT L. HAWKINS, M.Sc., F.G.S.

The Classification, Morphology, and Evolution of the Echinoidea Holectypoida.

4. H. LYSTER JAMESON, M.A., D.Sc., Ph.D., F.Z.S.

Studies on Pearl-Oysters and Pearls.—I. The Structure of the Shell and Pearls of *Margaritifera vulgaris* Schumacher : with an examination of the Cestode Theory of Pearl Production.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
November 28th, 1911.

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NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1911, p. . . . The Distribution is as follows:—

Part	I.	issued in	March.
"	II.	"	June.
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